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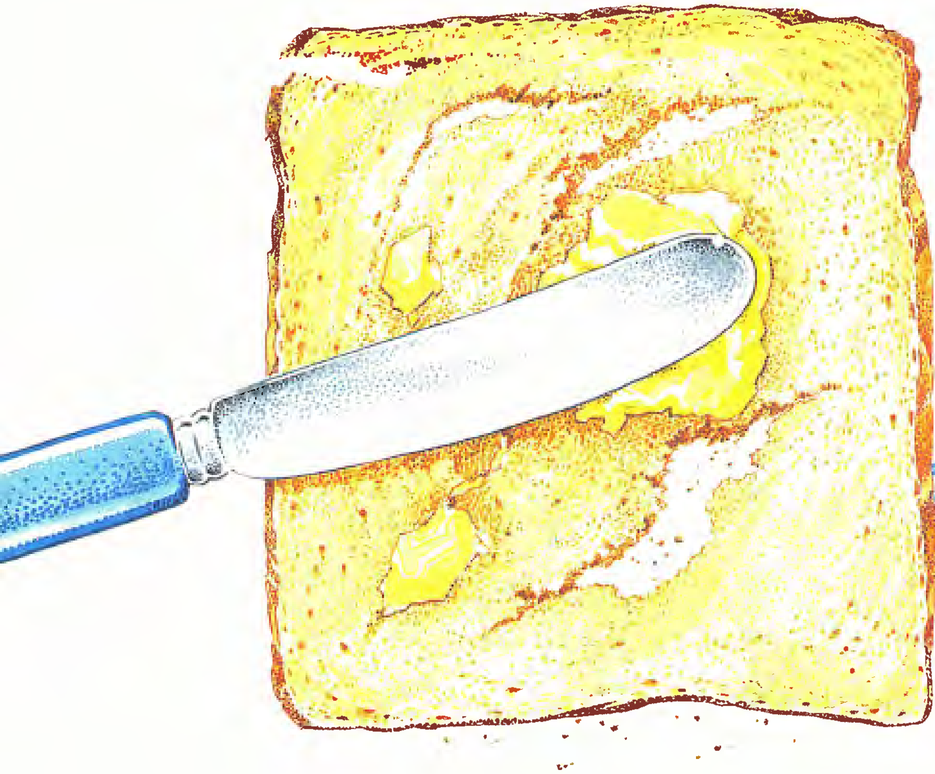
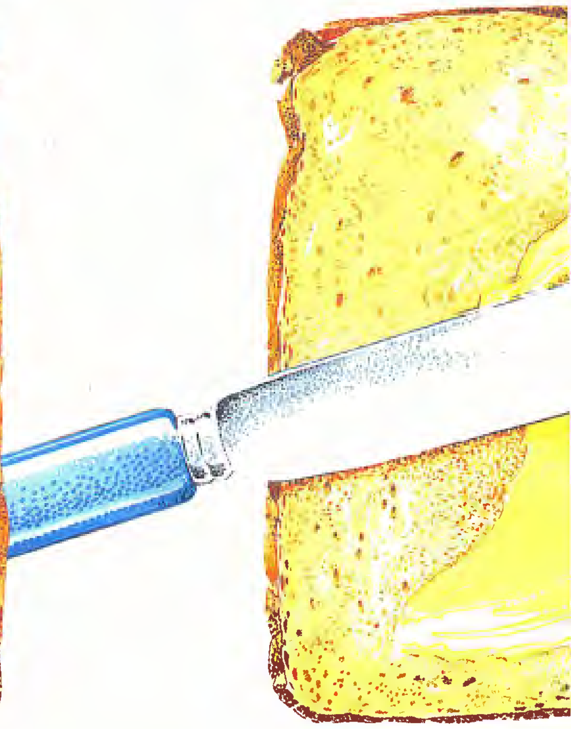


BUTTER USED TO BE HARD TO USE.



NEW TECHNOLOGY MAD

You're probably quite happy with your current word processing software. Then again, you were probably quite happy with hard butter. Certainly, hard and soft butter look and taste similar. But when soft butter came about, it made life a lot easier. Which is exactly what would happen should you use Microsoft Word 4 for IBM PS/2 P.C.'s and compatibles.

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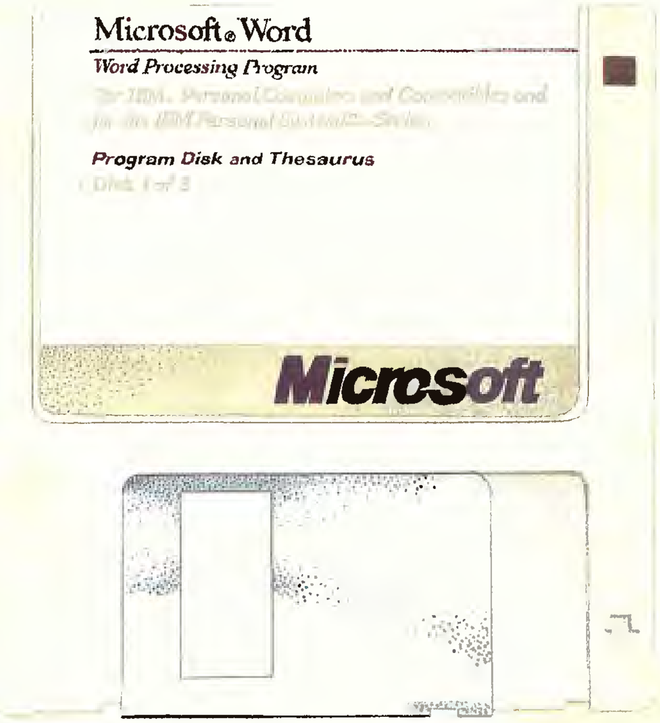

T MORE VERSATILE.

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To see just how much better Word 4 is compared to your present word processing software, simply call Microsoft now on (02) 452 5088 or toll-free on 008 226 850 and ask about the $25 evaluation pack.

In fact, as Microsoft are always ahead of the field, you should call them for any of your software requirements.

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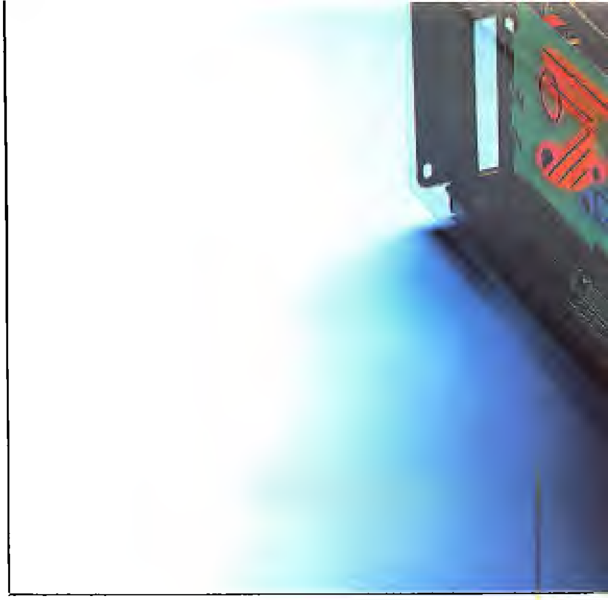

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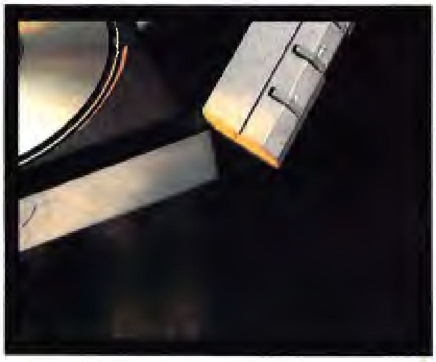

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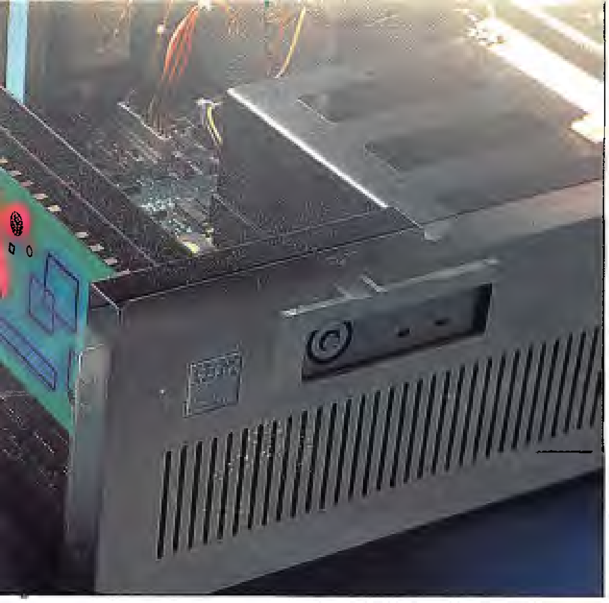

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READ THIS

Your chance to win $30,000 cash in the Microsoft Data Compression Competition ends at 5pm on January 4, 1988. Start compressing.

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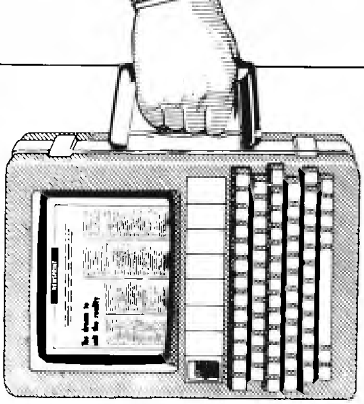


PS/2 clones are in the pipeline as compatibles manufacturers queue for Phoenix's recently announced PS/2 ROM BIOS — although they'll have to wait for PS/2 chip sets. Also, local Melbourne company, Porchester Computers secures the first Taiwanese 25MHz '386 machine.

Lining up for Phoenix PS/2 ROM BIOS

Thirty-seven computer manufacturers have signed licensing agreements for Phoenix Software's recently announced PS/2 ROM BIOS, according to Rich Levandov, vice president of marketing for Phoenix.

Compatibles makers eager to clone the PS/2 family still have to wait for PS/2 chip sets from chip makers such as Western Digital and Chips and Technologies, which should be available early next year.

The Phoenix PS/2 ROM BIOS products and compatible computers should reach the market by the second half of 1988, Mr Levandov said.

Phoenix demonstrated its PS/2 ROM BIOS software for the IBM PS/2 Models, 30, 50, 60 and 80 computers at Comdex, held last month in the US. Meanwhile, Award Software announced its PS/2 Model 30 BIOS and new versions of its XT and AT-ROM BIOS software.

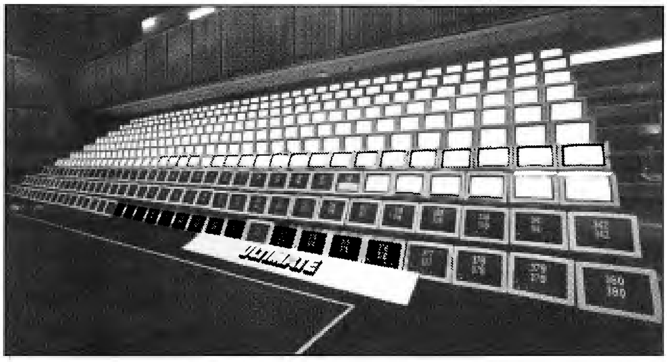
Compatibles makers using Phoenix's ROM BIOS could develop PS/2-compatible computers that are 100 per cent compatible with IBM's computers, Mr Levandov said.

These new PS/2 compatibles could support 3.5in floppy disk drives, a mouse, extended and expanded memory, and a bus functionally equivalent to IBM's Micro Channel architecture.

They will operate as fast as 16MHz for the Models 50 and 60. Model 80 compatible computers could operate as fast as 25MHz, a Phoenix spokesman said.

Award Software currently has prototypes of its PS/2 Models 50, 60 and 80 ROM BIOS software and final versions will be available to computer manufacturers in the first quarter, said Robert Hurt, Award's director of product marketing.

Award's OEM customers include Epson, Hewlett-Packard, Sharp Electronics and TeleVideo.



This blatant display of connectivity was seen at the Spectrum show held in Sydney recently, on behalf of Ultimate Computers.

Ultimate contributed to Wyse Technology's one millionth terminal sale worldwide, and no doubt had a hand in bumping Wyse's recently released quarterly net sales figures up 64 per cent from the same quarter last year to $US102.6 million.

The press release accompanying this cubist graphic stated that 380 Wyse terminals were connected up to perform this stunt (we have to take the PR company's word for it — although the photo only shows 109 terminals running. Bet they'll use non-reflective screens next time . . .). The same PR company failed to mention what computer was running the show.

We thinks it's not a Wyse.

Porchester scoops 25MHz '386 machine

Does a 25MHz 80386 machine, selling for $6500 sound, to say the least — good? And just to put things in perspective, bear in mind that a Compaq DeskPro 386 running at 20MHz with a 60Mbyte hard disk will burn a $16,573 hole in your pocket.

Porchester Computers has announced two 80386 machines: the Taiwanese-manufactured Skai 386-25, the first machine, (as far as we are aware) that runs at 25MHz, and the Skai 386-20 running at 20MHz. Both systems use the Phoenix Technologies ROM BIOS and can be configured to support up to 16Mbytes of 32-bit memory, with zero wait states. A VGA display will be available as an option in January.

Michael Neistat, managing director of Porchester Computers, stated that the Skai 386-25 is probably the fastest 386 computer on the market today. The machines will be targetted at corporate and government organisations, he said.

The $6500 price for the Skai 386-25 includes a 20Mbyte hard disk, EGA adaptor, colour monitor, and 1Mbyte standard RAM.

The 20MHz version (if

you're interested) will cost $5300 for the same configuration. (Rumour has it that this 20MHz 386 is actually faster than Compaq's 20MHz version.)

The Skai 386-20 is available now from Porchester Computers, and the 25MHz version is expected to arrive late in January,

Just in case you're wondering, these prices *do* include tax, and a 12 month national warranty support through Honeywell-Bull.!

For more details contact Porchester Computers on (03) 537 2722.

New breed of DOS software exploits '386 power

Applications specifically tailored to exploit the 32-bit architecture of the 80386 chip are finally arriving, letting users run DOS programs on '386-based PCs without having to wait for a new operating environment.

These '386-specific applications — which include databases, computer-aided design, computer-aided engineering and expert systems — often boast more than double the processing speed of their regular DOS counterparts running on the '386, according to vendors and users.

"In general, [the '386 applications] make things twice as fast and I don't have to change my operating system or change my batch files," said Jim Hansel, vice president of an institutional money-management firm, and a beta-test site for Borland International's '386 database, Paradox 386.

"It's fantastic. We see the benefits for anything with massive data transfers. You fly," said David Turk, senior project engineer, and an early user of Fox Software's Foxbase+/386 database.

The '386 applications are designed to address the six-month-to-one-year 'window of opportunity' that exists before applications written for OS/2 become readily available, developers agreed.

While OS/2 is a 16-bit, '286 operating system — and not a '386 operating system — it ostensibly will offer '386 users multi-tasking and access to more memory by breaking DOS's 640k memory barrier. Industry observers said an 80386-specific version of OS/2 is at least two years away, and the first OS/2 applications won't be seen until next year.

The new crop of '386-specific applications, on the other hand, gives users immediate access to more than 640k of memory, although they do not support multi-tasking.

In addition, the '386 specific products will run faster than OS/2 applications because OS/2 is not designed to handle the 32-bit processing that users want, developers said.

"People who have laid out lots of money for a '386 are hungry to take advantage of it," according to David Fulton, president of Fox Software, which offers FoxBase+/386.

Most of the '386 applications incorporate DOS extenders, which access as much memory as the '386 machine can handle — generally up to 16Mbytes. The increased memory affords faster, more efficient processing since the program doesn't have to leave memory to look for user data or other parts of the program stored on disks.

Paradoxically, to get the full power of the '386 today, you need to go to a DOS extender that supports that capability because OS/2 currently does not allow the '386 to operate in virtual mode," said John Dawson, director of research and development at Case Technologies. The company recently released Vanguard Stellar, a '386-specific computer-aided-engineering (CAE) product.

In addition, the '386-specific products gain speed by being recompiled to take advantage of 32-bit instruction sets unique to the chip. These instruction sets let the 80386 handle data in 32-bit chunks instead of 16-bit chunks, doubling processing speed.

Symantec Corporation's Q&A 386 database, for example, doesn't use an extender but gains a 40 per cent speed improvement from such recompilation, said Gary Hendrix, vice president for advanced technology at Symantec.

An analyst who is currently beta testing a spreadsheet written specifically for the '386 said, "These spreadsheets are able to get a twofold increase in speed over the regular software on a '386."

Graphics-intensive engineering programs work well on PCs running '386-version programs that incorporate DOS extenders, said John Cloyd, marketing manager of CADKey, a computer-aided design development firm, which will ship its first '386-specific product, Enhanced CADKey, in December.

"Our customers tell us they don't want to wait for OS/2. This is relatively cheap, relatively quick to bring to market, and they can see significant speed improvements," he said.

Many developers said their '386-specific software development hedges their bets on OS/2, reflecting their uncertainty about when the new operating system will take hold on the market.

"Our main design target is OS/2 with the Presentation Manager," said Ed Esber, president of Ashton-Tate. "But we will have a version of dBase that will run in the '386-specific environment using a DOS-extender product." He declined to reveal the product's release date.

Lotus upgrade

The long-awaited upgrade to Lotus 1-2-3, release 3.0, will be available in the second quarter of 1988, Lotus Development Corporation officials said last week.

Imagineering, the Australian distributor for Lotus products, is expecting to have release 3.0 available in April 1988. No price has been established, but it is expected that it will sell for $970 (the current price for 1-2-3 release 2).

Current users of 1-2-3 will be able to upgrade to release 3.0, and prices will range from $200–$300, depending on which version the user is upgrading from.

Lotus 1-2-3 release 3.0 features three techniques to speed up spreadsheet recalculation time, improved graphics, the ability to link multiple worksheets, and display three worksheets on-screen simultaneously. It also has HAL-like functions, including an Undo command and a macro keystroke recorder, according to Lotus officials.

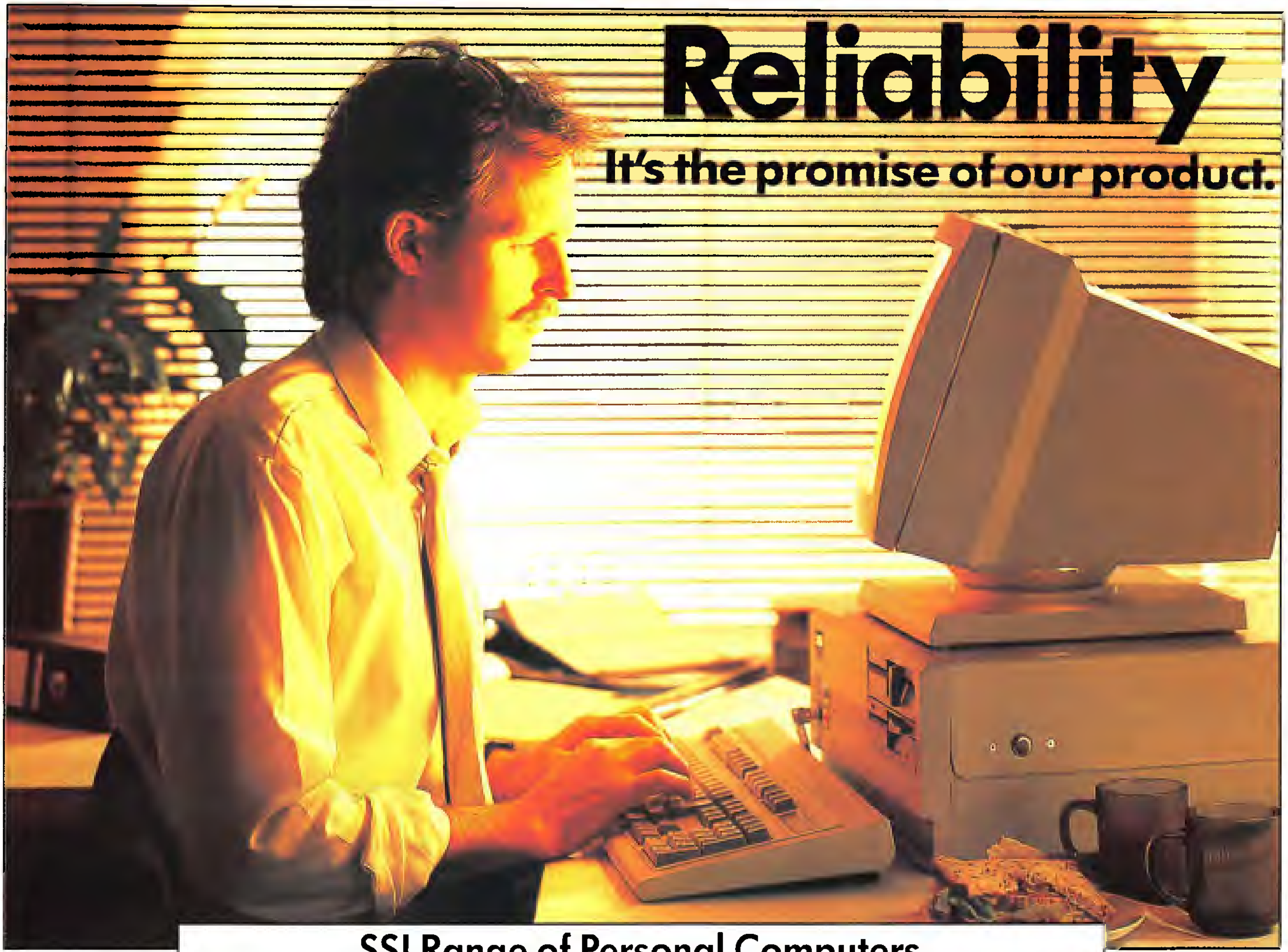
In order to handle linked worksheets and the new consolidation functions, 1-2-3 version 3.0 will also support a new file format in addition to its current .WKS format, several sources confirmed.

1-2-3/M, the forthcoming version of 1-2-3 for IBM mainframes, features the same functions and appears identical to 1-2-3 release 3.0, said a source familiar with the program.

The new release of Manuscript, also slated for introduction early next year, adds new features designed to help reposition it from a technical word processor to a routine office product that can compete with such programs as WordPerfect or Microsoft Word, the sources said..

A spokeswoman for Lotus acknowledged that an upgrade of the $970 word processor is in the works but declined to provide additional details.

Nonetheless, sources who have seen or tested pre-release copies of the program said it now features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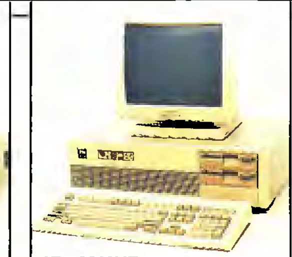
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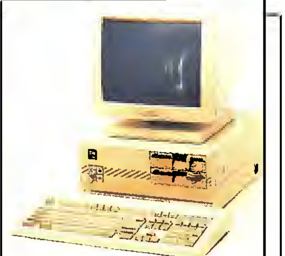
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embedded support for Adobe System's PostScript page-description language, the ability to display full-screen previews of graphic images in Manuscript documents, mouse support and a library of graphic and text elements borrowed from Lotus's Freelance.

The new Manuscript also includes a keystroke recorder for building macros that is designed to make the process of handling and moving graphics in a document easier, the sources said. The new release operates nearly twice as fast as the current version and will be able to import and export data in formats compatible with IBM's Document Content Architecture, they added.

Finally, the next version of Symphony, 2.0, includes incremental enhancements to all modules in the integrated program, sources said. The program, which is not copy-protected, will include two add-ins — Symphony Spelling Checker and Symphony Text Outliner — according to the sources.

Among the new enhancements are improved recalculation in the spreadsheet, more efficient memory management and new database functions for editing records and fields through menu options, they added.

Much-touted word processor for Mac

A much-heralded new word processor for the Apple Macintosh, FullWrite Professional, from Ann Arbor Softworks, is expected to be shipped within four weeks, according to company officials.

Demonstrated publicly for the first time in August at a Macintosh trade show in the US, the program shares many features with Microsoft Word 3.01: a word processor with an integrated outliner, spelling checker and the ability to produce and lay out multi-column documents that contain both text and bit-mapped graphics.

FullWrite Professional is expected to be available in Australia in January, and will cost around $800, according to Mr David Fox, marketing director of InfoMagic, the Australian distributor.

Ann Arbor's president, Mr Phil Lipitz said, "Our intent is to go after Microsoft Word and other Macintosh users who have been trapped into using desktop-publishing programs."

"Most Mac business users," he said, "need the desktop-publishing look, but don't want hassles associated with [learning to use] those programs."

FullWrite Professional, along with several other new Macintosh software products, is expected to be the vanguard of an all-out attack on Word 3.01, the current Macintosh word processing market leader, said Bill Higgs, a software analyst with market researchers InfoCorp.

By the end of January 1988, several companies, including WordPerfect Corporation and MicroPro International are expected to release comparable products into the fray against Microsoft, which lays claim to 60 per cent of the Macintosh word processing market.

Most of the forthcoming Macintosh word processing programs include features previously available only in stand-alone Macintosh desktop publishing products, according to Mr Higgs.

For example, FullWrite Professional provides WYSIWYG capability; contains a notes modes for annotating a document with hidden or visible text, which can also be used as audit trail; and has the ability to wrap text around graphics.

Additional features of Ann Arbor's new program, said Mr Lipitz, include the ability to control the density (darkness) of text or graphic images — called grey scaling — when documents are sent to PostScript-equipped printers such as Apple Computer's LaserWriters.

FullWrite Professional contains drawing software for creating or annotating bit-mapped images in a document, Mr Lipitz said.

Unlike a number of other Macintosh programs, such as Microsoft Word 3.01 and MicroPro's recently announced but unnamed Mac word processor, FullWrite Professional will not include utilities or other software that converts data files created with DOS-based word processors into Macintosh compatible formats, Mr Lipitz said.

The incredible spreadsheet market

Try as I may, I can make no sense of the spreadsheet market; and the arrival of Microsoft's Excel (reviewed in this issue) and Borland's Quattro, both out to rival Lotus 1-2-3 and Symphony, doesn't help.

When Excel was available only on the Macintosh, some people said it was so good that people might desert the IBM standard just to run Excel.

On the PC it runs under Windows 2, and the graphical interface does mean that you are better off running it on a powerful machine — at least a souped-up AT clone running at around 10MHz. When you've got that, they say, it's just wonderful.

I declined the opportunity to view it, just as I passed up the chance to see Quattro, which some people have said is nice.

My own interest in Borland has focused on two products: Sprint, the word processor; and SideKick II.

Sprint is so far behind schedule that I don't believe it. I actually saw a book, published by a third party, on how to use the program; and despite having signed a non-disclosure agreement to allow me to beta-test the thing, I still haven't even seen a disk with bugs on.

Last time I looked, the company was raving on about 'disclosing major strategic directions for Paradox', which turned out to be a plan to make it work under OS/2 and Unix, and able to work with SQL, an IBM standard for data extraction from databases.

I hate to say it, you guys, but what you are currently doing is blundering around with a credibility problem.

Could you get to work on it, please?

Guy Kewney

Presenting in the New Year . . .

As we move towards 1988, industry analysts will be called upon to tell other interested industry folks what they think the hot topic of this new year will be. One will certainly be fax boards for PCs; another will be connectivity. But according to industry luminaries such as Apple's president John Sculley, the fastest growth area will be desktop presentation.

Sculley believes that there are more desktop presenters than there are publishers — and most analysts agree. Desktop publishing is a department concept; desktop presentation is much more personal.

The key to desktop presentation lies in a new type of software that specifically allows the user to design slide or overhead presentations as easily as DTP programs churn out great newsletters. Living Videotext's More was the first of this kind of new software, and Microsoft's Powerpoint is the one that has helped the industry understand how valuable this presentation idea can be.

A recent product announcement by Cricket Software, called Cricket Presents, is perhaps the best of this new breed as it adds colour and draw op-

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NE002

tions. And, Macromind's Videoshow 2 adds animation to this presentation concept.

Although the type of computer you use is important, with the Mac being the best so far for this type of application, even non graphics-oriented PCs can be used effectively.

Harvard Presentation Graphics and Brightbill-Roberts' Show Partner are the leaders in presentation software for the IBM world. But you can expect many other companies to have PC products like this out in 1988 as well.

Ironically, the most important part of this equation rests in the area of output devices. The main machines used for desktop presentations to date are the image recorders used for 35mm slide-making. The leader in this area is Presentation Technologies' Imagemaker. AT $US4995, this low-cost slide-making machine has great resolution, and Apple has endorsed it as a major part of the Macintosh desktop presentation marketing program.

Another important product in this category comes from General Parametrics in Berkeley, California. Its Video Show II system is the only one that will allow you to import still video images into the PC.

General Parametrics uses the advanced Targa boards and a powerful compression program that can give a 10:1 compression ratio. As a result, digitised images can be stored in a much smaller disk space.

Additionally, the company offers a sophisticated drawing program that can handle 5000 colours with computer-aided programs, and over 100,000 colours with digitised images. At $US8295 for the base unit it is rather expensive, but if you do a lot of high-end presentations, then this device will pay for itself in no time.

The devices that are needed to really make this idea take off are colour printers. One such machine is the Mitsubishi/QMS PostScript colour thermal transfer printer. But at over $US12,000 it will be targetted more for departmental use rather than personal use.

The printer that *everyone* is waiting for, though, is the colour laser. Unfortunately, the technology needed for these printers is far from being perfected in any cost-effective manner, and the colour lasers that will come onto the market in 1988 will be priced at anywhere from $US35,000 to $US50,000.

In 1988, the market will show whether desktop presentation is just an extension of desktop publishing, or an independent enough concept that customers will buy a complete system for just this application. When this markets starts to grow, high-end service bureaux using the $US50,000+ Genagraphics slide-making machines could be hurt by these low-cost solutions which threaten their business in the same way that desktop publishing has affected the typesetting industry.

Tim Bajarin

Roll out the red carpet

At a Mac users' meeting I overhead someone say that they would kill to get their hands on a portable Mac. Mac users are addicted to their machines, and go through heavy withdrawals when they have to be away from their babies.

Although two companies have already given us pricey versions of this good machine — Colby and Dynamac — the industry is still waiting for Apple Computer to bring out the 'real lap-top Mac'.

There are plenty of rumours that Apple is working on such a machine. But John Sculley, Apple's president and CEO, continues to claim that it will still be some time before Apple releases a true Mac laptop. Nonetheless, sources inside Apple confirm that there have been three solid prototypes of a lap-top Mac, and that the development of this machine is moving along rapidly. In fact, these sources say that things are going so well that we might even see this lap-top version as early as March 1988, when Apple will apparently roll out its colour SE and the new 68020-based laser printer.

What would this Mac laptop look like? Most observers doubt that it will copy the Dynabook concept which Apple Fellow Alan Kay envisioned (see the Alan Kay interview in this issue). This is supposed to be a true notebook computer.

Most believe that Apple has really taken to gas plasma displays as well as the LCD backlit technology that is gaining real market acceptance. It is also likely that the machine will be mains rather than battery-powered.

Sources who have seen this machine say it looks a lot like the lap-top Macs already out, but they expect the final product to be sleek and sexy and much more efficient in the way it works with the user.

Sources also say that it will be very expensive at first.

Even if Apple does not release this machine in March, it is believed that it will appear some time in 1988.

And, for the Mac addicts who never travel without their Mac and only feel safe with Apple logo products, this may be the machine for them.

If Apple *does* release a Mac of this type, you can be sure that third-parties will cash in.

Tim Bajarin

Dropped into the lap of the gods

In 1983, industry researchers made outrageous claims about the potential market for lap-top computers. They said that laptops would dominate the market and have developed into a $US10 billion industry by 1987. And, they said that the market leader would be Gavilan Computer.

Gavilan *who*, you ask?

Gavilan was the first company to make an IBM PC-compatible lap-top, and it did so at a time when the IBM PC had not been quite accepted as a standard. Nonetheless, these researchers were fascinated by the compactness of the lap-top concept, and had delusions of grandeur.

To date, the lap-top is still not the hit these pundits said it would be.

The main reasons for the slow growth of the lap-top market have been technological in nature. Poor screen resolution has been a major problem; and combined with the laptops' heavy power consumption and weight, users tended to develop gorilla arms and bloodshot eyes from lugging them about.

In the last 18 months, radical new technologies have improved the appeal of lap-top computers. The backlit LCD has made screens more readable, while power consumption has been reduced. At the same time, disk drive weights have come down, thus reducing some of these single-drive machines, such as the Toshiba T1000, to as little as 2.75kg.

Talking to most lap-top buyers today reveals that laptop computers are regarded as secondary productivity tools — for use when travelling or working in a place where there is no access to the 'serious' desktop PC. The new generation of 80286 and 80386 portables will have great impact on the desktop's potential in the market, but, as they need mains power or have limited working life in battery mode, they seem destined to be used as compact desktop units rather than as true portables.

But, many industry leaders

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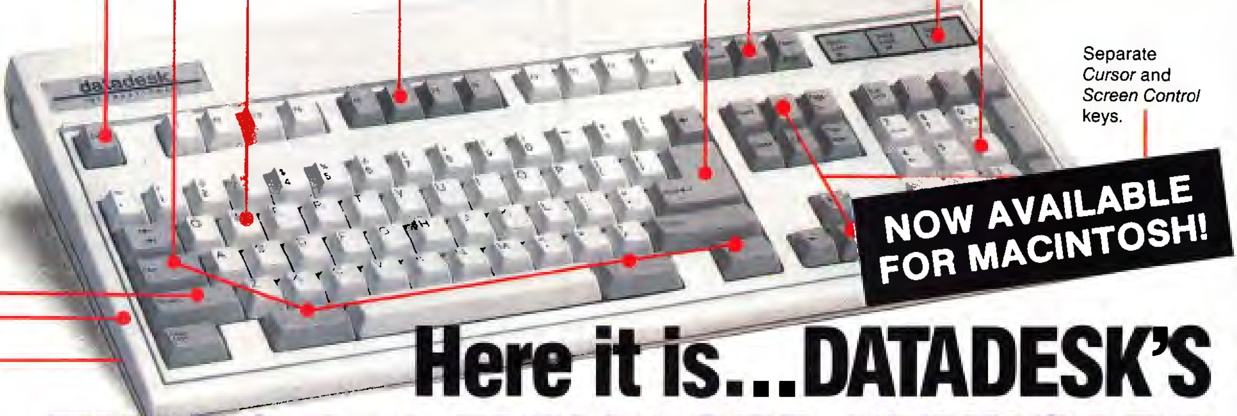

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believe that at least two major lap-top manufacturers are developing technology that could change the face of computing forever, and fulfil the expectations of the pundits of 1983. Nonetheless, the predictions of four years ago were probably eight to ten years off the most likely date when lap-tops will gain acceptance in the market.

The first major development is of low-power, high-speed microprocessors. AMD has perfected a CMOS version of Intel's 80286 chip and could have it in production early next year. Intel is also working on a version of this chip, also for release next year.

Although gas plasma is considered the best screen technology available for lap-tops, it is hungry for power and expensive. One major vendor is perfecting an LCD backlit technology that uses a fluorescent light to increase the screen's resolution and contrast, and at the same time give the user over four hours of battery-driven power.

Sources who have seen this screen say it could destroy the demand for gas plasma or EL screens, as it offers similar resolution while using only one quarter of the power.

Quadram has used a slicing design in its Snap 1+1 so that a user can have a basic unit with drives in the main base, and add extra power through snap-on devices.

Another major player is preparing to introduce a new type of high-resolution EMS standard memory on the main board, 4Mbytes of memory and a 40Mbyte hard disk.

This system will weigh 4.1kg without the battery, and, when powered by a battery, the user will get up to four hours' use.

These new technological breakthroughs, if fully implemented, could have a real impact in the office. Lap-tops with this kind of power could become primary computers for any user, and perhaps even cause the standard desktop units to fade into oblivion. Desktop units of the future might become high-powered workstations, with lap-tops becoming the main personal productivity tool.

To draw a parallel, before microchip technology, calculators took up large spaces on a desk. But, miniaturisation has produced powerful calculators that fit inside a wrist-watch. Roll on the wrist-bound PC!

Tim Bajarin

Editor's note: the Macintosh utility we raved about last month has, as predicted, made its way to our shores. Suitcase is now available from Softserve; call toll-free on (008) 07 4155.

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Atari CD-001

To all outward appearances part of a conventional hi-fi unit, the Atari CD-001 boasts excellent audio, video and digital facilities at a knock-down price of $999 Nick Walker takes it for a spin.

By now almost all hi-fi enthusiasts must have discovered the compact disc. These small, shiny, rainbow-colored plastic discs offer a quality of sound previously only available from a ludicrously expensive record deck. What the average hi-fi enthusiast might be unaware of is that there are up to 800Mbytes of random access data held on a single CD. Just to put this in perspective, 800Mbytes is the equivalent of 2000 thousand floppy disks, 250,000 sheets of A4 text or 500 full-length novels.

CD-ROM, as the technology is known, is the data storage form of audio compact disc technology and has been around for some two years now. While the price of an audio compact disk player has dropped from around $600 to $400, the CD-ROM has remained fairly static in price at around $1700 to $2000. Considering that a CD-ROM is in some ways actually less complex than an audio CD player (no need to transform the digital information into analogue sound), this seems a little unfair. The obvious solution is to take an audio CD player and modify it to give a digital output — and this is exactly what Atari has done. The Atari CD-001 is a Shinon midi-sized audio CD player modified to give a digital output and costs only $999.

History

The earliest micros used 8in floppy disks as their mass storage medium and were capable of storing approximately 90k of data. As time passed, both floppy and hard disk technologies progressed, disks got smaller and capacities got much larger. It is now possible to store up to 7Mbytes of data on one high-capacity floppy disk and 500Mbytes on a single, incredibly expensive, hard disk.

In order to store such large amounts of data, storage designers turned away from traditional magnetic storage towards optical media. At first glance, optical discs have a great deal going for them: they offer fantastically high capacity; they are rugged; and they cannot be accidentally erased. But they do have their problems, not least the difficulty involved in manufacturing an optical disc which can be written-to many times.

Optical discs can store much more data in a given area than magnetic disks because optical discs use the narrowest form of read-head available — a laser beam. The surface of the disc can be either reflective or non-reflective; when laser light is shone onto the disc, the amount of light reflected is greater or smaller respectively. These two states allow binary 0 and 1 to be represented, and therefore make it possible to store digitised data.

Much of the development of optical storage media and methods has been carried out over the years by Philips. It was also Philips which released the first commercial product based on opti-

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ATARI
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cal disc technology — the video disc player. This held digitised television pictures on a large 12in disc. Although the video disc has been used in interactive training situations and some arcade games, it was not a raging success and the lesser-quality video tape recorder still reigns supreme.

Undaunted, Philips, with the aid of Sony, came up with the compact disc (CD). This is based on the same principles as the video disc but is much smaller (12cms) and is designed specifically to store audio signals. An audio CD player runs the digital data through a very high-speed D to A converter to produce an analogue signal which is amplified and fed through the speakers.

In terms of physical format, there isn't much difference between audio CDs and CD-ROMs. The music, after all, is held in binary format in exactly the same way as computer data. The main difference between audio and computer CDs is in the players. While the laser, servos, and so on, remain unchanged, computer CD-ROM drives have extensive error-correcting circuitry built-in, giving a bit error rate of better than 1 in 10^{12}. The logic of this is that even the most dedicated hi-fi enthusiast won't notice a slightly off-tone

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1/10,000 of a second, but a computer can't accept a single error.

At this point it is probably worth briefly mentioning WORM (Write Once Read Many) drives. WORM drives are optical disks that you can write to once and then read as many times as required. At the moment WORM drives are typically 10 times the price of the Atari CD-ROM and hold half as much data on a larger 12in disk.

Atari CD-001

The Atari CD-ROM is a free-standing unit that obviously started life as a straight audio midi hi-fi unit. If it wasn't for the fact that it is painted the usual Atari light grey, it would look great as part of a midi hi-fi stack. At the moment the CD-ROM is only designed to connect to an Atari ST, but Atari plans to produce PC expansion cards to allow PC users to use the CD-001.

For a CD-ROM that is also an audio player, the Atari CD-001 is remarkably devoid of flashing lights and buttons. The front panel houses two LEDs ('power' and 'busy'), a head-phone socket, the open-close button and a tiny removable remote control unit. The remote control unit clips neatly into the player and consists of just four buttons — play, stop, next track and previous track.

> *'The combination of CD-ROM, video and audio offers enormous potential of applications...'*

Inserting compact disks is done in the same way as in audio players: you press the open/close button and the drawer slides out awaiting a disk. The rear of the drive is even more bare than the front, consisting of two phono outputs and a single 19-way D-socket. The D-socket can be connected directly to the hard disk DMA port on the ST, so data transfer should be fast. The prototype model I reviewed also had an emergency reset switch but this won't feature on the final version. The retail version of the CD-001 will have a second DMA port to allow you to attach a hard disk or any other peripheral that uses DMA. The important thing to note about the DMA port is that it gives two-way communications, so the ST can control the operation of the CD

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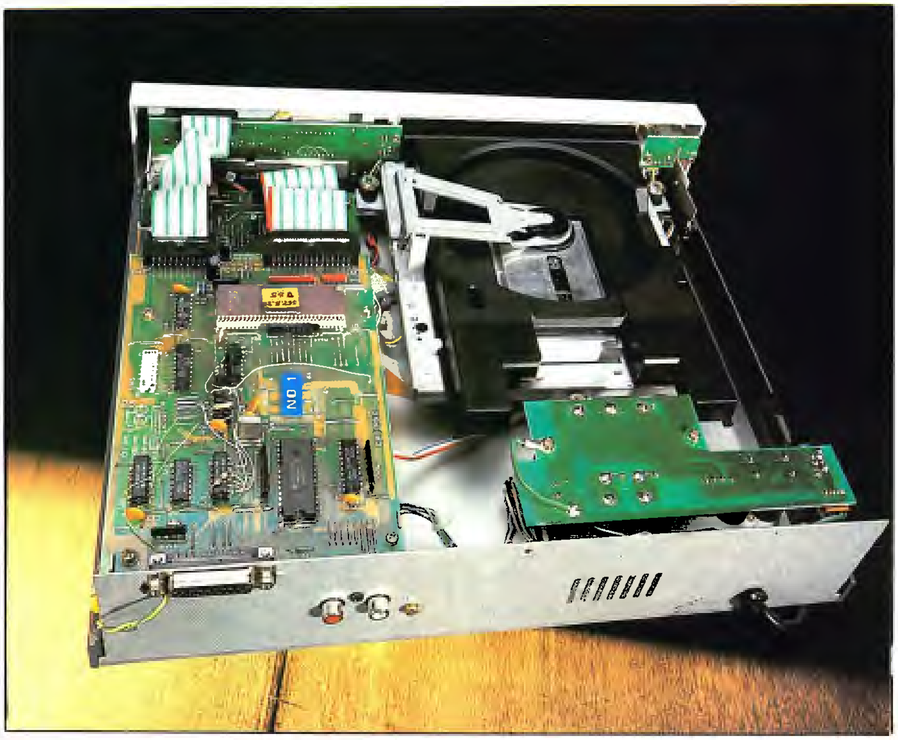
player. The digital output on certain audio CD players is of no use at all with CD-ROM as there is no way to control it. The only possible use for this output is with digital audio amplifiers and speakers.

I was given strict instructions by Atari not to open the unit up, but with only one screw holding down the lid who could resist? Although, there were signs of an early prototype (lots of patch wires and cludges) the general impression was pretty favourable. The left-hand side of the case was dominated by the player mechanism and behind this was the power supply. To the right are two PCBs, one above the other. The lower board which survives the process of being turned into a CD-ROM practically unscathed. A tiny ribbon cable runs from this to the upper board which contains all the advanced error correction and interface circuitry. In total, there are around 14 chips on the lower board and 24 on the upper board. As the design is finalised, the chip count on the upper board should be considerably reduced, making it very cheap to manufacture.

The drawer mechanism, laser and servos are originally manufactured by Philips. For those interested in the technicalities of this hardware, it is a single laser beam mounted on a swivel so that it can scan the whole disc. Data is read in 16-bit blocks with 4-bits between each successive read, hence each datum is read four times (known as 16-bit, 4 times over-sampling).

In theory, a single CD-ROM could contain 800Mbytes of data but this is reduced to 600Mbytes in the case of the Atari owing to formatting and organisational considerations. In general, a CD-ROM player has a similar seek time to an early floppy disk and a transfer rate somewhat faster than most hard disks. However, the seek time refers to searching through 600Mbytes of data rather than the usual 360k. The only official figure released by Atari is a transfer rate of 4.3Mbits per second. In practice, I found it took about two seconds to find and retrieve a single piece of information and three seconds to find every reference when using my *Grolier Encyclopaedia* CD.

As far as the Atari ST is concerned, the CD-ROM behaves just like a very high-capacity hard disk. The example disk I had was formatted in a special way to give very fast access but it still responded to the attempts I made to access as a hard disk. Within Atari in the US there is a CD that boots up just like a hard disk and contains a vast number of ordinary files.



Looking at the Atari CD-001 from the rear: the player mechanism and power-supply are visible to the right with the two PCBs to the left

The one feature that distinguishes a CD-ROM player from its audio counterpart is the increased error correction needed. A certain amount of misread information can be tolerated by an audio system because the player just repeats its last fragmentation of music; the fragment is so small that you never notice the error. A misread piece of information on a CD-ROM could cause the computer to crash. The error correction circuitry within the CD-001 is bought in by Atari from a company called KnowledgeSet. For those interested in a bit of history, the chairman and founder of KnowledgeSet is Gary Kildall, the man who founded Digital Research and CP/M.

Unfortunately, KnowledgeSet is very secretive about the error correction circuitry used, so all I can tell you is that it works. I've still to find an answer to why the same circuitry can't be used to give superlative hi-fi. So, if anyone has got the answer, please let me know. (Clue: I think it has something to do with the different bandwidths of CD-ROM and CD audio).

Atari claims that the CD-001 is also capable of 60 minutes of video output. To put the record straight, there is no video output from the CD-001 and there won't be for at least another year. KnowledgeSet, in conjunction with RCA, is working on a system of very efficient data compression that will allow 60 minutes of digitised video to be contained on a single CD. When this becomes available, KnowledgeSet plans to add it to all its boards, including the ones for Atari. This 60 minutes of video is in a different format from the recently announced CD-V from Philips, so you won't be able to play the new pop video CDs on the Atari player.

Software

The only example CD-ROM program I had was the *Grolier Encyclopaedia*. This is an American Enyclopaedia which comes as four weighty volumes. The software to drive it dates back to early 1985 when Atari first threatened to make a CD-ROM and is, therefore, a little crude in design. It should be considerably improved by the time it is released in Australia, however. The opening screen depicts a 26-volume bookshelf with each volume corresponding to a letter of the alphabet. Clicking on the spine of the book takes you through to a second screen showing an alphabetical breakdown of the volume (that is: GAA-GAM, GAN-GER, GER-GIS, for example). Further subdivision continues until you get to a level where all the entries are listed alphabetically; clicking on a single item then brings up the relevant entry.

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What makes the Grolier software really useful is its intelligent search options. From the search screen it is possible to find all references to a certain word or collection of words. All the usual logical functions can be applied (AND, OR and NOT) and it is also possible to specify the maximum distance between one word and another. For example, if you wanted to find all references to Sugar and South Africa, you would simply type in 'Sugar AND South Africa' and specify within, say, 50 words. After approximately three seconds, the software will return all the matching sections from the encyclopaedia.

The *Grolier Encyclopaedia* was also created by KnowledgeSet with the co-operation of Grolier. Using a suitable scanner the entire text of the Encyclopaedia was transferred to disk; then every single word in it was indexed. The entire text on a CD is then represented as a series of pointers to this index; not only does this result in a faster access time for searches, it also gives a data compression factor of around 25 per cent.

KnowledgeSet has agreed with Microsoft and other CD-producing

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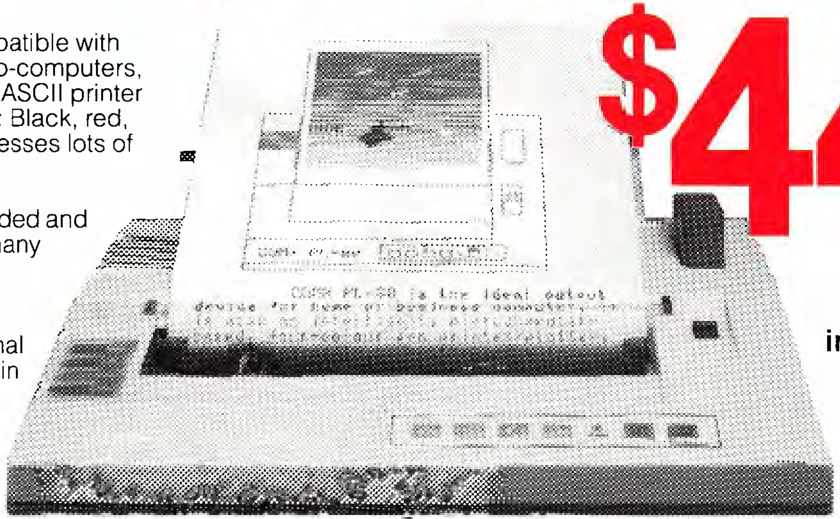

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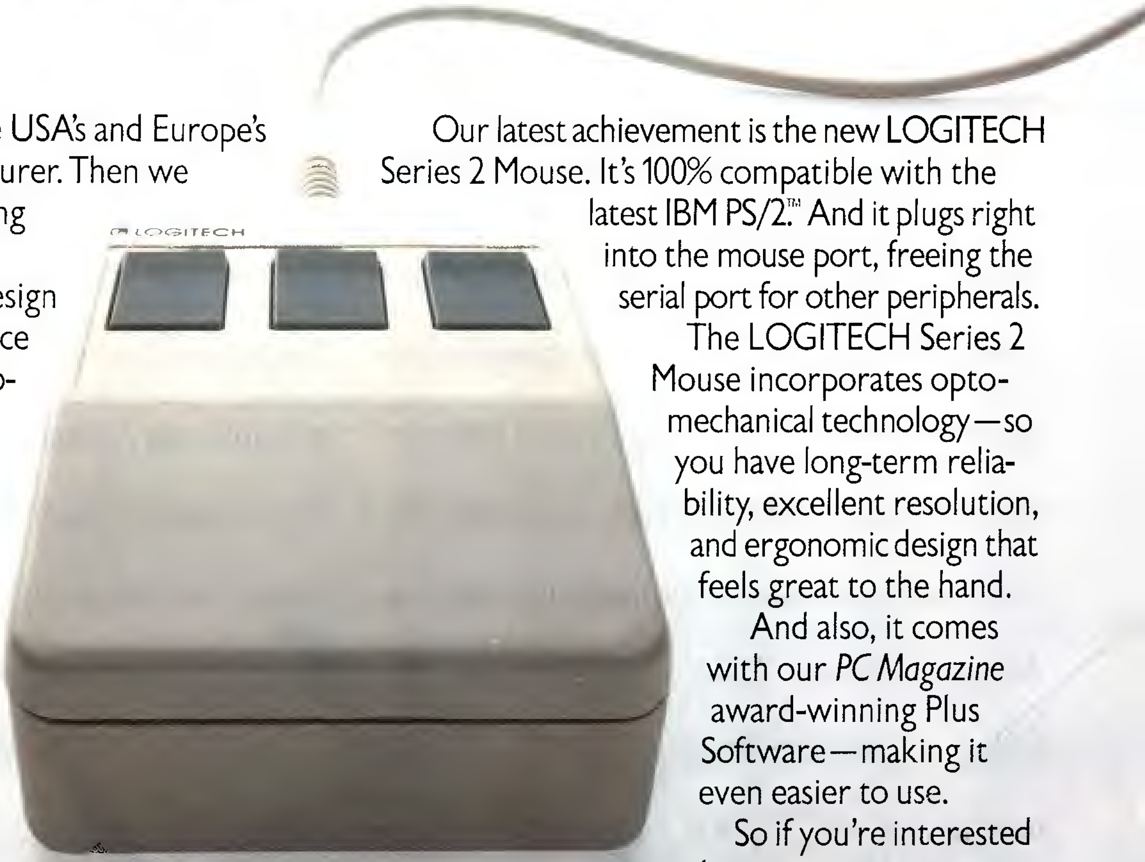

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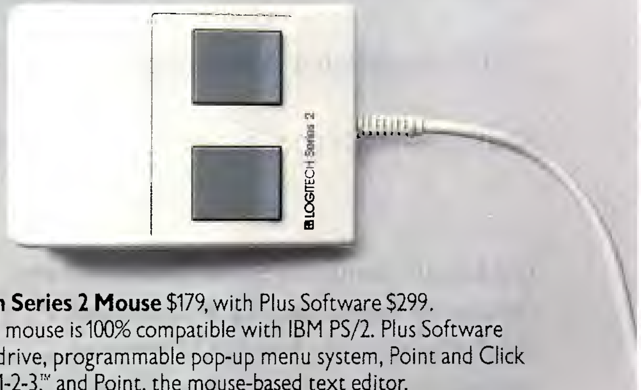

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The Atari as an audio CD player

The Atari CD-001 has the look and feel of a low-end midi hi-fi unit. However, the usual problem with low-end CD players being unable to track a damaged disk, did not occur at any time during my test. Disk handling is rapid and sure, especially on the next track and previous track functions. Resistance to shock and microphony (vibration caused by low bass sounds) is excellent. To produce an analogue audio output, on every high-speed DAC is used shared between the two stereo channels — a set-up that is considered mundane by today's standards.

In musical terms the Atari turned out to be a truly excellent player in relation to its price, taking into account the extra feature of CD-ROM and CD video. Although arguably a little indistinctive, the Atari still sounds very much alive and detailed, especially on classical pieces. The presentation is slightly soft and spatially flat, but the musical integrity is much better than the brash sound of other low-cost players I have heard. Anyone who is buying a CD player for the first time, whether a hi-fi enthusiast or not, should find the Atari a pleasure to listen to. If you are considering using the unit mainly as an audio player with only occasional use of the other features, it would be worth your while listening to the latest Philips 960 range for comparison.

software houses to produce all disks using the same standard. In theory, this should mean that the CDs produced by most other manufacturers can be read by the Atari CD-001. The only problem is that most of the major manufacturers such as Microsoft are only interested in the IBM PC market, and the software used to access the CD will probably only be available in IBM PC format.

Also on the same floppy disk as the Grolier software is a simple program that allows you to control the playing order of an audio CD. At the moment this just allows you to select your favourite tracks and play them in any order you want. I can see no reason why this couldn't be extended to give the equivalent of Philips FTS (Favourite Track Selection). As every audio CD has a unique index number, it would be possible for the computer to memorise the favourite tracks for all the CDs in a collection and just play these tracks whenever a CD is inserted.

Obviously, an Encyclopaedia is just one of the thousand of possible uses for CD-ROMs. Already under production are dictionaries, thesauri, phone books and drug catalogues, to name but a few applications. Numerous software companies are also looking into distributing software on CD to overcome the number of disks needed and also for increased copy protection. The combination of CD-ROM, video and audio offers enormous potential of applications in such markets as training, design and, of course, games.

Prices and availability

The Atari CD-001 will costs $999, and according to Nigel Shepherd, managing director of Atari Computers in Australia, is expected to be available in March or April, 1988.

Conclusion

Since Jack Tramiel took over at Atari, the company's claim has been 'Power without the price'. Never has this been more true than with the Atari CD-001. A CD-ROM player for $999 is a bargain in itself, and combined with CD audio it is astoundingly good value for money.

The only question-mark hanging over the future of the CD-001 is the availability of software. Until lots of players have been sold, very few software companies are going to go to the enormous expense of producing software. Hopefully, potential purchasers will be satisfied with the little software there is at present and the ability to use the player for music as well.

A number of large corporations have expressed an interest in the CD-001 for their own internal use and I expect this will help boost the unit's popularity.

In the long term, I see magnetic media being abolished in favour of battery-backed RAM disks of a similar medium being used for software distribution and back-up.I personally can't wait to have 800Mbytes attached to my ST, but I never did get on with magnetic media.

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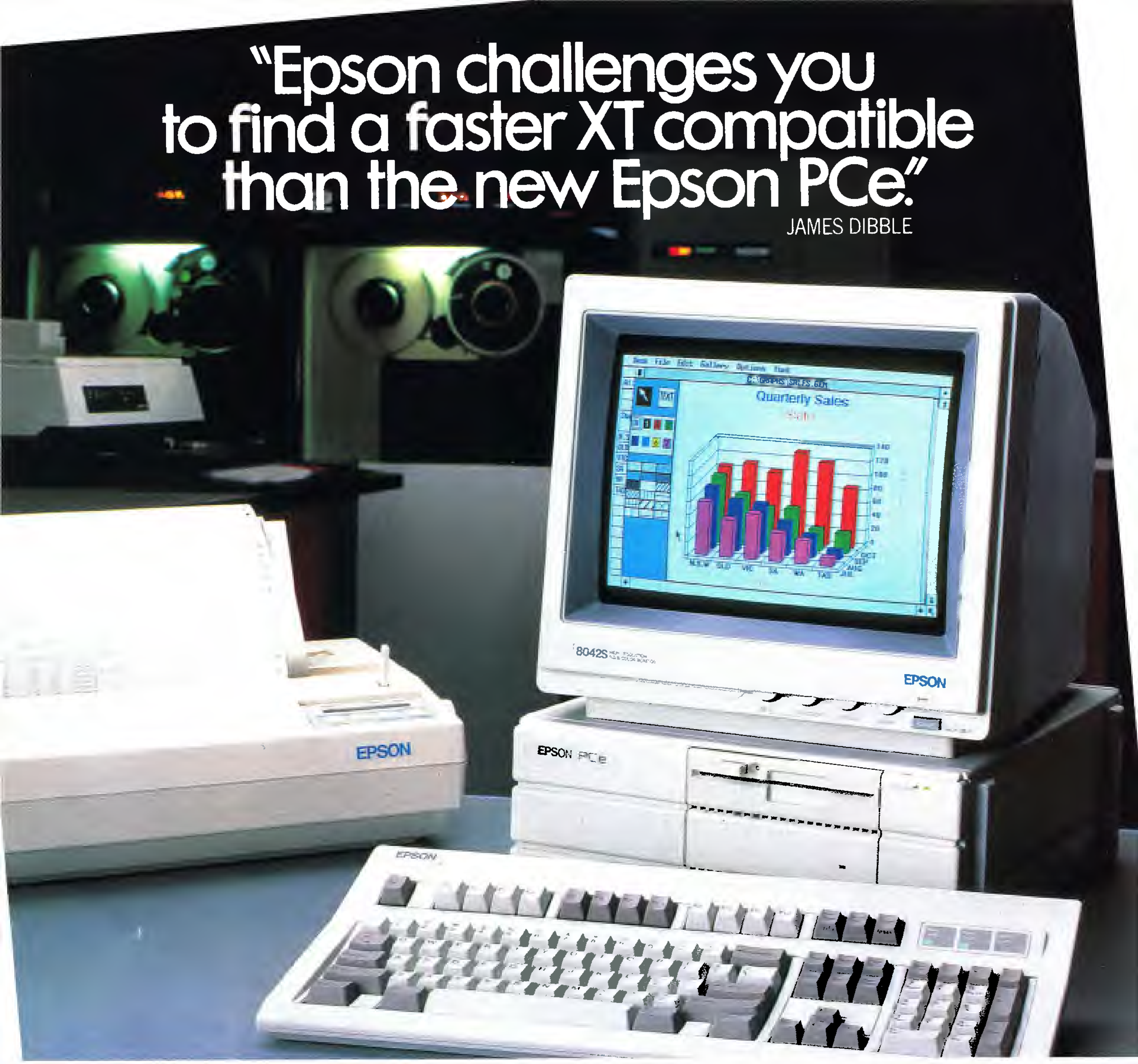

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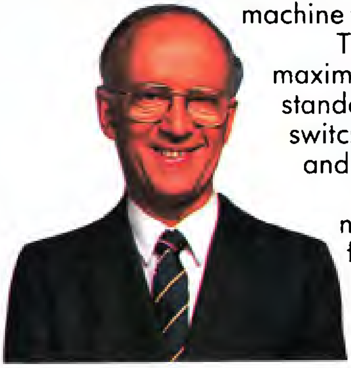

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Microsoft Excel

Microsoft's Excel is a powerful, sophisticated spreadsheet which runs under Windows and has the potential to overtake Lotus 1-2-3 in the popularity stakes. But how do its features compare with those of its established Macintosh relative? Anthony Meier finds out.

Microsoft's new spreadsheet program, Excel, looks set to leave Lotus 1-2-3 and its lookalikes well behind in the spreadsheet stakes. It promises to be the most powerful and user-friendly spreadsheet written to date. It is being introduced as the third-generation spreadsheet for personal computers, and is designed primarily to run on machines based on the 80286 and 80386 microprocessors. Macintosh users will be familiar with this program already, as a version of Excel has been available for this machine for 24 months or so (see the 'Function comparison' box for a comparison between the two versions).

Overview

Excel is a sophisticated piece of software which offers many advanced spreadsheet facilities and programming features, an integrated onsheet database and a wide range of charting and graphing facilities. It is the first spreadsheet in the MS-DOS environment to offer interactive, dynamic linking of worksheets, a one-step automatic macro recorder and high-resolution output. It runs under Microsoft Windows 2.0 and takes full advantage of all its facilities, providing multiple worksheets in overlapping windows onscreen, pull-down menus and full mouse operations.

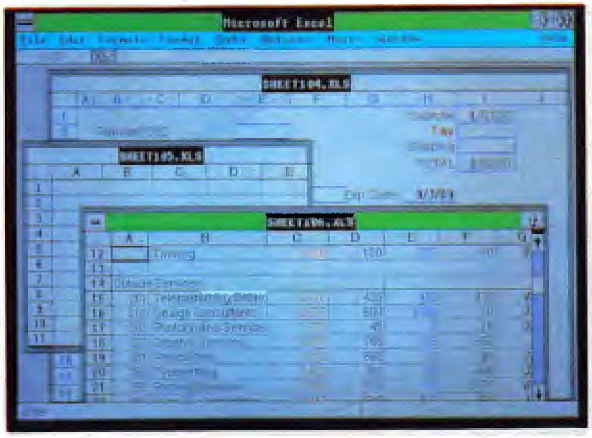
A run-time version of Windows 2.0 is bundled with the program for users without the full version. A version of Excel is also planned for the OS/2 operating system. Windows 2.0 has an identical interface to that of OS/2 with Presentation Manager, so Excel users should find making the transition to that new operating system easy.

The machine I used for the review was an AT compatible with 20Mbyte hard disk, EGA card, colour monitor and mouse. I also had an AST card installed which increased the memory from 640k to 2.5Mbytes to give more room for testing large spreadsheets. There is only about 140k available for data on a standard 640k machine.

Installing the program on the hard disk was very simple. It involved inserting the setup disk, typing 'setup', and following the instructions given on the screen. These asked for the other disks supplied to be inserted one by one until all the necessary files had been copied across. I was supplied with 14 disks, eight of which contained the files for Excel, the other six were files for run-time Windows.

In use

When the program had been installed and loaded, I found Excel very simple to learn and use. Virtually all of the user-friendly features of the Macintosh version were present — windows, pull-



Excel makes use of the ability of Windows 2 to have a number of spreadsheets open at once. The arrows at the top left size the windows. The most obvious difference from Excel on the Apple Macintosh is the use of colour

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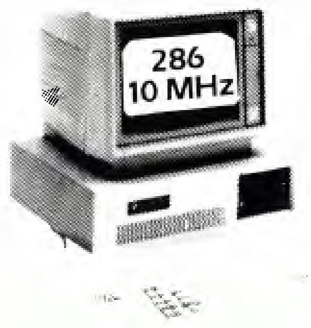

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MODEL:	2200	2112
CPU:	286 @ 10MHz	286 @ 12.5 MHz
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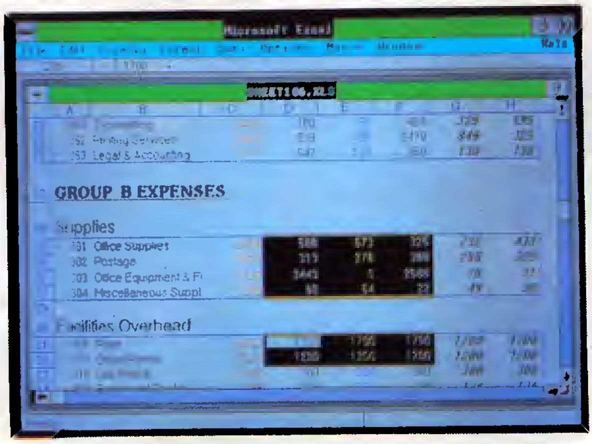
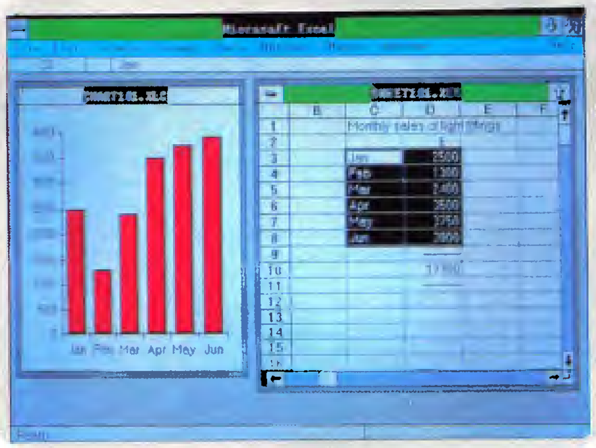


Fonts, type styles and colour can be used to enhance the appearance and logic of a spreadsheet both onscreen and when printed. Debits, for example, could appear in red



Charts are created by selecting an area of data and then choosing a chart style option. Charts are automatically updated as the data changes

down menus and intuitive operation with the mouse. There was comprehensive online help and an online tutorial.

The initial screen presents a new, blank spreadsheet window called 'Sheet 1' to let you start working straight away. If you want to create another new document, you pull down the 'File' menu with the mouse and select the 'New' command. This brings up a dialogue box which asks you to select the type of document you want to create: you can choose between a worksheet, a chart and a macro sheet. To select one of these, you can click once on the relevant option button with the pointer and once in the 'OK' box; or you can double-click the relevant option button. Either method creates a new window containing the new document. Macintosh users will be familiar with these mouse techniques; it's surprising what you can do with combinations of clicking, double-clicking and dragging.

The mouse can be used to give all the commands and instructions you need in Excel. It saves you from having to learn and type in commands at the keyboard, and makes program operation very fast. You can also keep your eyes on the screen instead of continually glancing at the keyboard. However, keyboard lovers can still use the keyboard instead of the mouse for all the commands and operations they need — even moving and sizing windows. Pressing the 'Alt' key makes the menu bar active, then pressing the underlined letter of the menu title you want (or using the cursor key and 'Return') pulls down that menu. Finally, pressing the underlined letter of the command you want (or using the cursor key and Return) invokes that command. Pressing the 'Esc' key cancels the menu selection.

The mouse, however, does make it quick to select a cell, or cells, for data entry — you just move the pointer to the cell you want and click to make it active. You then need to use the keyboard to type your data in. The mouse can also make operations like inserting and deleting rows and columns, and cutting, copying and pasting cells, very fast.

> *'Excel is a sophisticated piece of software which offers many advanced spreadsheet facilities and programming features, an integrated onsheet database and a wide range of charting and graphing facilities.'*

The mouse also comes in handy for entering cell references into formulae. Instead of typing in a cell reference, you only need to point and click on the cell in question for its reference to be automatically inserted into the formula. Dragging the pointer across a range of cells inserts that range into the formula. And you can include references to cells on another spreadsheet (linking the spreadsheet) just by clicking on the cells in that other spreadsheet. This saves time setting up formulae and speeds up the creation of models.

Spreadsheet handling with Excel is very impressive. You can have several spreadsheets, charts and macro sheets onscreen at the same time, each one in its own window, like so many pieces of paper. You can shrink or expand the windows, depending on which one you are working on, and you can transfer information easily from one to the other. Spreadsheets can be easily linked, allowing you to consolidate figures from as many different spreadsheets as desired. Because you can work on many spreadsheets at once, you can see the effects of changes in one worksheet on other linked worksheets immediately on the screen.

Each spreadsheet has a maximum of 16,384 rows by 256 columns, and it is easy to move quickly to any desired location using the mouse on the scroll bars along the sides of each window. Column widths and individual row heights can be adjusted easily with the mouse. Each window has a horizontal and a vertical split bar which you can use to divide the window into a maximum of four panes, to see different parts of a spreadsheet next to each other. You can also open up new windows for the same spreadsheet if this is more convenient. As you are expected to have many windows fighting for space on your screen, there is a window menu which lets you select the window you want, to bring to the top of the others.

Functions

Excel has all the features and functions you would expect to find in a top spreadsheet package, such as cell protection, calculation options and zero

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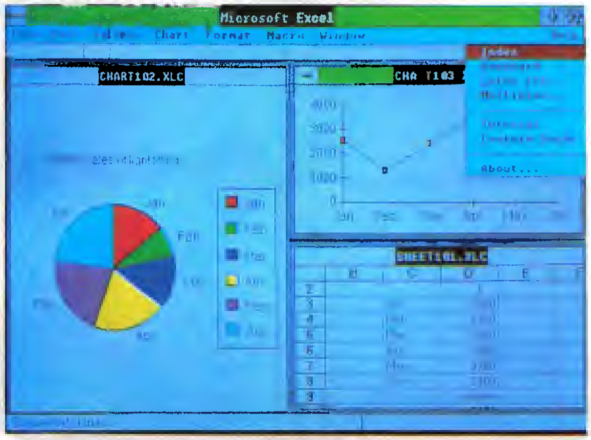
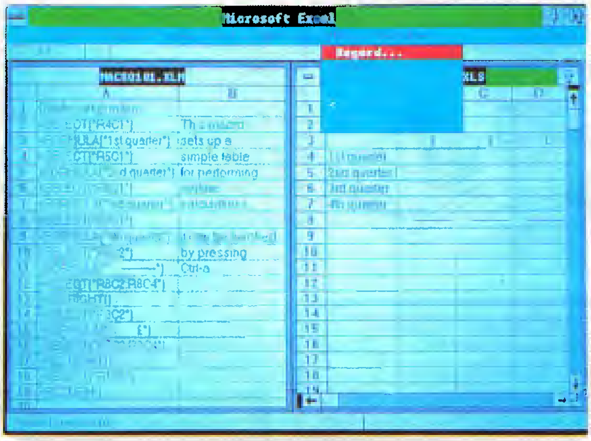


Many chart styles are available. The 'help' system includes a cross-reference to Multiplan and 1-2-3 commands, so users who know what to do in those programs can transfer across



Macros can be created line by line or recorded; this allows Excel to 'learn' a process that the user performs. A separate module allows for the conversion of 1-2-3 macros

suppression. It has an 'undo' feature that can reverse your last command if you make a mistake, and it also has a matching 'repeat' feature that you can use to repeat your last command.

Excel only recalculates those cells that have changed since the last calculation, thus speeding calculation. It also uses 'background' calculation which lets you continue working while it recalculates. And it doesn't require you to wait until all the cells have been calculated before you can start working again, which is a nice feature.

Excel has more functions than both Lotus 1-2-3 Version 2 and Excel for the Macintosh. The accompanying box gives a comparison, although functions

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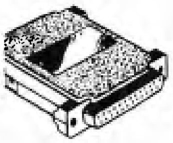

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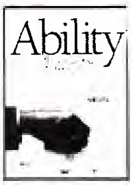

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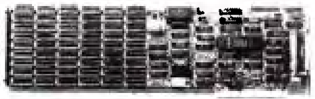

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alone should not be used as a guide to a program's overall capabilities.

Many of Excel's functions are similar to those of Lotus 1-2-3, so 1-2-3 users should be able to build spreadsheet models with Excel's functions without too many problems. Some of the interesting new functions provided by Excel are as follows.

The 'information' function, CELL(type-of-info, reference), returns information about the formatting, location or contents of the upper left cell in 'reference'. CELL("width", F13), for example, would give you the column width of cell F13. CELL("format", B12) would give you information on the cell formatting.

The text function, CODE(text), returns the numeric ASCII code of the first character in 'text'. CODE("Alphabet"), for instance, would equal 65. CODE(B5) would equal 70, where cell B5 contained the text "February".

Excel can be used for working on arrays, which are groups of two or more values that can be used like a single value in formulae and functions. Excel also has matrix functions which can be used for working with these arrays. The matrix function, MMULT(array1,array2), returns the product of two arrays, where both arrays contain only numbers. This might be written as MMULT(A1:B2,D1:E2).

Compatibility with Lotus 1-2-3

Many of Excel's new users are expected to be previous Lotus 1-2-3 users, and Microsoft has developed tools and functions within Excel to make learning and using the program easier for these users. The features will also help Excel integrate more easily into a Lotus 1-2-3 environment.

For beginners, two-way file compatibility enables spreadsheets to be exchanged between the two programs. Then there is a useful 1-2-3 macro translator that can automatically convert nearly all 1-2-3 macros into Excel macros. A '1-2-3 Help' facility lets users type in the command sequences they would have used in 1-2-3 and automatically gives them the corresponding Excel commands.

Presentation features

Excel's presentation facilities are very impressive, and provide you with a wide range of screen display and printing options. You can turn the spreadsheet grid on or off, show or hide the row and column headings, switch them between R1C1 and A1 according to your personal preference, and choose between different font types and sizes. You can use up to four different fonts on one worksheet — individual row heights will automatically adjust to accommodate the font sizes you choose. There are 19 number-formatting options which are meant to be used for things like date formats, decimal places, commas and negative brackets.

Individual cells can be emboldened, underlined or italicised. You can add shading, create boxes or lines around cells or blocks of cells, and control screen colours to enhance the appearance of the screen display or printed document. You could have all the positive figures in a column display automatically as blue, and all negative figures red, for instance. All these facilities help you to produce printed documents that rival word processor output and can be used for final reports and presentations.

There is a page preview facility to let you see a miniature version of your page as it will look when printed out, which is very useful for checking pages before printing them. It is also useful for viewing large spreadsheet models like a map to give you a better idea of what they look like.

Printing

A wide variety of printers and plotters are supported, and your own printer

How Microsoft Excel compares to the Macintosh version

On running the Windows version of Excel for the first time, I was amazed at its similarity to the Macintosh version. The look of the spreadsheet with its cell grid, the cross pointer, the menu options and the way in which the mouse operated are all the same. The ways in which you create macros, databases and charts are the same, too. On closer inspection there are a few differences, all of them turning out to be improvements.

The Windows version I used did not seem to be as fast, however, but the final release version should be faster as all the debugging code will have been removed.

The Windows version has all the features of the Mac version with many more besides. The first new feature difference I noticed was a status line at the bottom of the screen that gives brief explanations of each command as you move through the menu options — very helpful for the first-time user. Another feature is that you can choose between short and full menu options: short gives you the most commonly-used commands and may be more suitable for beginners; full gives you the complete range of commands.

On the Mac version you can adjust only column widths on a spreadsheet, but on the Windows version you can adjust the row height of individual rows as well. You can also use more than one font on a worksheet. Both these features give you a lot more flexibility in designing models and spreadsheet reports.

On the Windows version, there is a new 'Arrange Windows' command that automatically resizes and fits all your windows into neat boxes on the screen to let you see them all side by side. I found this feature very useful when my screen became cluttered with several spreadsheet windows.

The 'Resume Excel' feature from the Macintosh version has been enhanced in the form of the Workspace feature on the Windows version. This lets you save all open worksheets and window arrangements you are working on for any particular project as a workspace file, to which you can give a name. You can then reload that workspace file (or any other) if you wish to continue working on that project, and all your worksheets and windows will be opened up exactly as they were when you saved them.

The auditing and documentation features of the Windows version, described in the main text, are an important new addition that makes the Windows version useful and practical, and there are also many new spreadsheet functions (see the 'Function comparison' box).

There are other differences too, but for day-to-day operations the programs are basically the same; and a Macintosh Excel users should have no problem at all coming to grips with complex spreadsheets on Excel for Windows. However, the Windows version offers more features and functionality which power users find very useful indeed.

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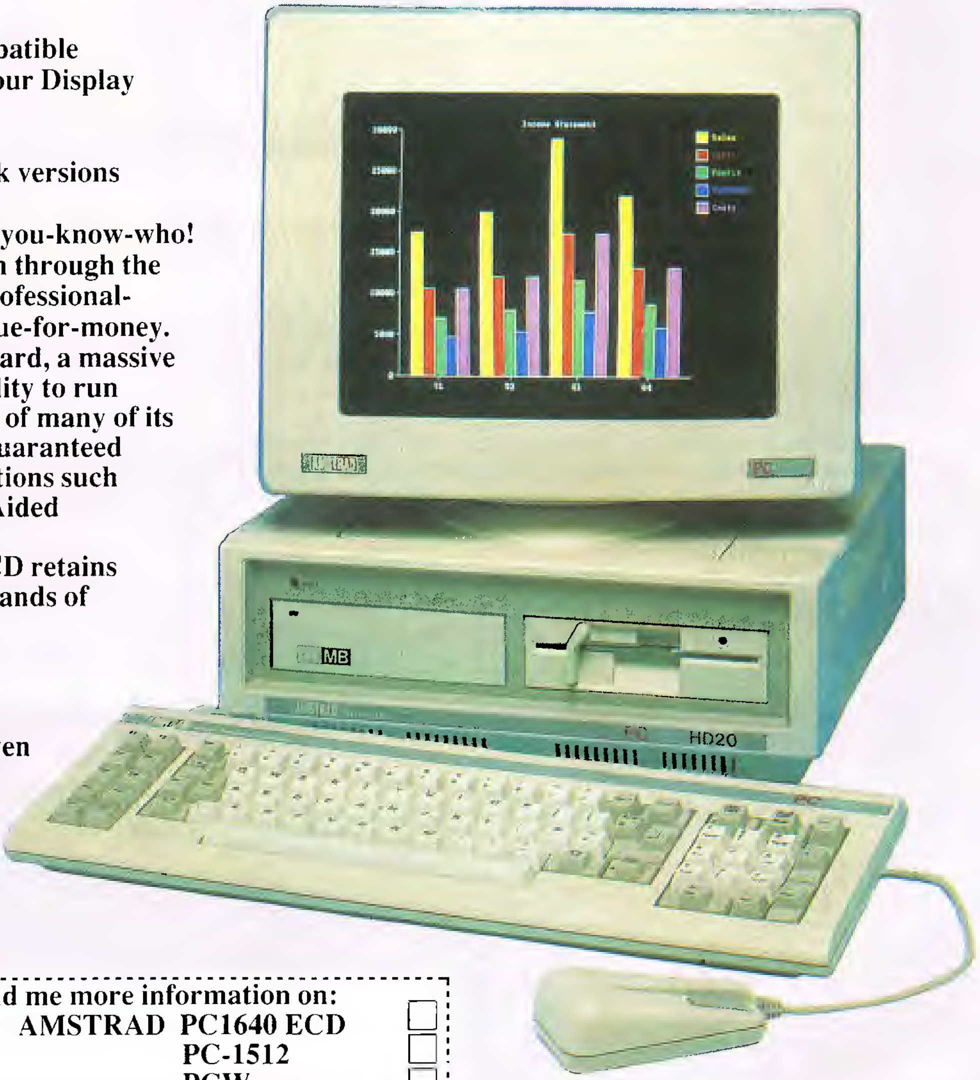

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and plotter drivers can be installed during the 'SETUP' procedure. High-resolution graphics printers are required if you want to take advantage of the graphics output of the program — a laser printer would be ideal.

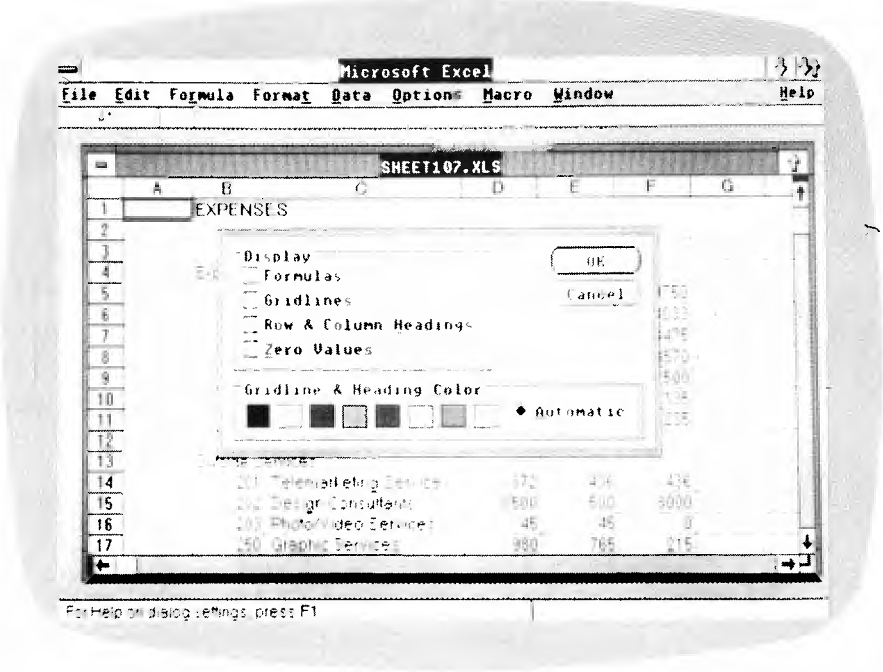
Excel includes a sophisticated printer spooler that lets you queue up print jobs, control the printing operation and continue with your work while they print in the background.

Charts

Excel has sophisticated charting and graphing facilities. A wide range of charts can be summoned instantly from selected spreadsheet cells and will change shape automatically if the cell contents are changed. You can see a chart in one window change as the data in the spreadsheet window alongside it is altered.

To create a chart from data in your spreadsheet, you first need to select the data you want to chart. This can be done by dragging the mouse across the relevant cells to highlight them, then you select the 'File New' command and click on the 'Chart' option. This creates a new chart window that automatically contains a default-type chart built up from the values in your highlighted cells.

The program has 44 pre-designed chart formats grouped into seven types of charts: area, bar, column, line, pie, scatter and combination. When any of these is created, the program provides default labels and designs. The charts are highly customisable, however, and most of the parameters can be altered to suit your own requirements. You can alter the colours, add text labels and legends, and scale the chart horizontally or vertically to get it to look just the way you want.



EXPENSES

Display
☐ Formulas
☐ Gridlines
☐ Row & Column Headings
☐ Zero Values

Gridline & Heading Color
● Automatic

For Help on dialog settings, press F1

An Excel worksheet can be as plain or as detailed as you want, with grid lines and headers being optionally shown in various colours and styles

Auditing and documenting

Excel has very useful auditing and documenting features. These help you check the logic and formulae in your model, track down errors and discrepancies, and document your model for your own reference and for other users. You can attach notes to any cell and view them using the 'Show Window Info' command. This command also shows you other information such as the cells that contain references to your active cell (dependents) and the cells that it refers to (precedents).

You can use the 'Formula Select Special' command to highlight all the dependents and precedents in the worksheet for easy identification. You can also automatically find all the cells with notes or those containing a particular formula.

These features are a great help when you are creating or amending a spreadsheet model and when you are checking its logic. They reduce the risk of missing important cells and making errors.

Excel has sophisticated cell-naming features, too. You can name each cell in a block of cells automatically by using a combination of the titles in your row and column headings. You can easily find cell references in a spreadsheet and replace them with names, and you can find cell names.

You can define a name which is not attached to a particular cell, but which refers to a value: 'INFLATION', for instance, can be defined to be '8%'. Then, whenever you use the name in formulae in your spreadsheet (and in other spreadsheets) it will equal 8%.

Macros

Excel has powerful macro facilities which let you pre-program the system to perform calculations and operations automatically. Excel macros have their own programming language and are created on separate macro sheets

Function comparison

Function type	Lotus 1-2-3	Excel (Windows)	Excel (Macintosh)
Maths/Trig	17	26	18
Logical/Special	18	34	23
Text/String	18	21	8
Date & Time	11	12	10
Financial	11	13	8
Statistical	7	14	11
Database	7	11	7
	89	131	85

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which are handled in the same way as spreadsheets. The macro commands are typed into cells in a column and, like cells on a spreadsheet, can be deleted, copied and moved around. You can have as many macro sheets as you want, and as many different macros as you can fit on each macro sheet. The macros can then be used with any spreadsheet.

You can incorporate branches and loops into your macro, and control can pass from one macro to another if certain conditions are satisfied. You can create 'intelligent' macros to interact with the user, for example, to prompt for information at certain stages, using dialogue boxes.

There is also a group of macro commands for customising the appearance of the program itself. You can set up your own menu bar and menu options, and create your own commands and dialogue boxes. You can use these facilities to effectively create your own custom applications within Excel.

The automatic macro creation facility can be used to build macros if you want to avoid programming — this works by simply recording actions you perform. The 'Record' command starts the macro recording, after which you can perform the task you want to record. When you have finished, you give the 'Stop Recorder' command. When the macro has been recorded, it can be edited and added to just like any other macro. In fact, you can see your macro being created line by line as you perform the actions it records. You can do this if you place the macro sheet window next to your worksheet window.

Macros can also be used for creating new spreadsheet functions: these are called function macros as opposed to the command macros just described. The 131 functions already available cover most of the standard purposes I can envisage, but function macros can be created for more complex, customised requirements. A function macro called 'TAX', for example, could be set up to calculate the tax due for a given set of variables such as gross pay, tax code, month, and so on. Function macros can be used in formulae in the same way as standard functions.

Database

Excel has on-sheet integrated database facilities with 11 database functions and a new feature, an automatic database form interface. Any rectangular area of the spreadsheet can be designated as the database area, after which its rows become database records and its columns database fields. All the database functions, like 'EXTRACT', 'DSUM' and 'DMAX', are then available for acting on the information, but these don't interfere with other spreadsheet functions which can be used as normal.

The 'Database Form' command is used to bring up the automatically-created form window, which you can use to enter, edit, delete and find records. The form resembles the standard form layout screen that many database programs provide, and makes using the database very simple.

The macro facilities can be used in conjunction with the database facilities to perform customised database operations and create customised database applications.

Data transfer

Data transfer facilities are very important, as you may often need to import data from other programs to Excel in order to perform analysis and create reports from it. Excel can read and write files in any of the following formats: text, CSV (comma separated values), SYLK, WKS and WK1 (Lotus 1-2-3), DIF, DBF2 and DBF3 (dBase II and III). This is a comprehensive range and facilitates the exchange of data with a wide variety of programs.

The Dynamic Data Exchange (DDE) protocol resident in Windows can also be used by Excel to exchange data with other programs running under Windows.

Documentation

The Excel manuals are well up to Microsoft's usual standard, and I didn't have to refer to them too often since the program's menu options are fairly self-explanatory.

Conclusion

Excel is an impressive program, and there is no reason why it should not ultimately overtake Lotus 1-2-3. It has superior power and ease of use, more facilities, and it is easy for 1-2-3 users to upgrade to. I have been a regular user of Excel on the Macintosh for some time, and I am confident that Excel for Windows will serve me equally well.

END

Excel costs $994. Microsoft is on (02) 452 5088.

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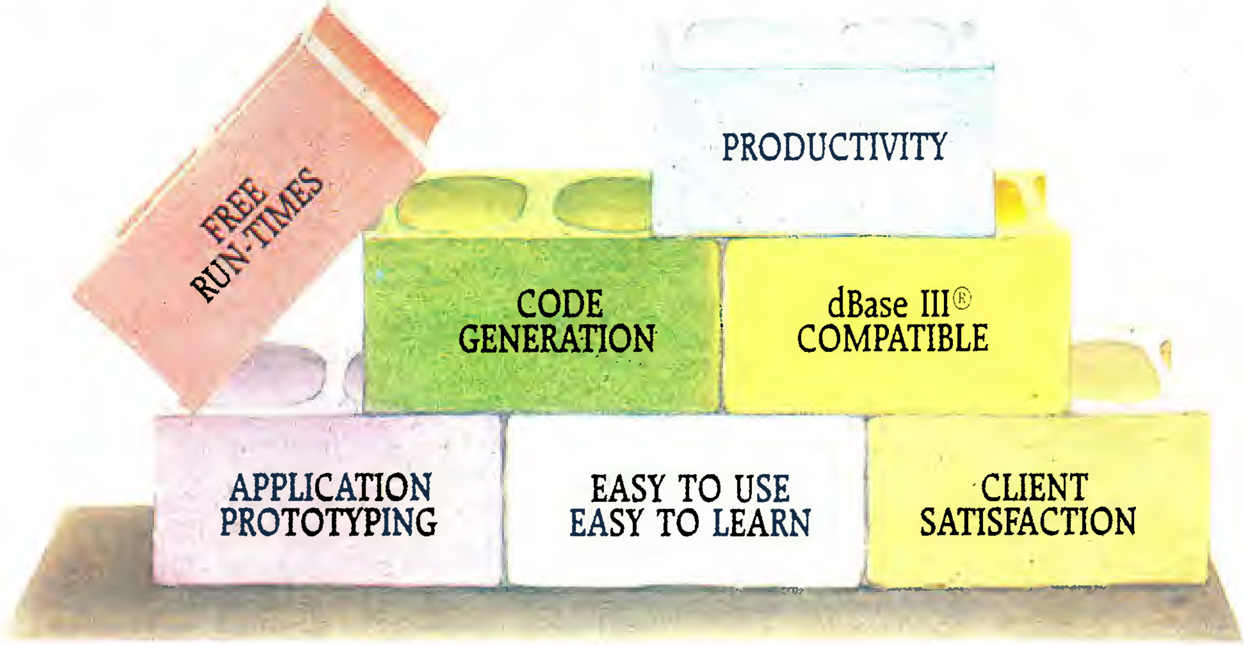

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G1: ACQB. Arm Chair Quarterback is a football strategy game. Rules are explained. You provide wits, the computer action.

G2: AFGHANISTAN. War Game with choice of weapons and roles.

G3: ANTONYMS*. Word game that challenges you to find the opposite of nominated words. Source provided.

G4: ASTRO. Dodging enemy ships and meteors. Well animated. Suit all ages.

G5: BABY. Gruesome but popular Kong-type game. Climb levels whilst avoiding the falling babies.

G6: BACKGAMMON. A good version of this popular board game.

G7. BASEBALL*. Match play with strategic choices of play for pitching, hitting.

G8: BEAST. Marauding beasts chase you through a hi-res maze.

G9: BIORHYTHM*. Prints chart of emotional, mental, physical biorhythms.

G10: BLACKFRI13*. Investment simulation. Try to increase value of portfolio without going broke.

G11: BLACKJACK. Good version of this popular card game.

G12: BLUESBOX*. Easy to use song composer.

G13: BRICKS. Quick moving game where you hit a ball against a wall to demolish it. Like playing squash against the computer.

G14: BUGS! Centipede creature hunts you through the forest. When you fire and hit it, the creature multiplies! Fast game.

G15: CATCH88*. Sky is raining letters and numbers. Catch them by correctly matching.

G16: CHASE. You're in a high voltage maze, chased by robots. Compiled with Pascal source code.

G17: CHESS*. Well designed, good board on screen.

G18: CIA*. Adventure with spies and other sinister doings.

G19: CIVILWAR*. Tactical simulation based on actual battles in Civil War.

G20: CRISIS. You're our last hope to save the world from alien invaders.

G21: DIGGER. Fun to play. Good graphics as digger digs tunnels for gold/emeralds while hungry creatures hunt for digger.

G22: DILEMMA. You have to outguess your opponent. Cooperate or oppose?

G23: DOTS*. Board strategy game against the computer, joining dot with lines.

G24: DSK. Disk Crash. As a floppy disk you have to avoid the falling magnets.

G25: DRAIN. Joke program which causes computer to pretend it's awash and needs to drain.

G27: ELECTION*. Simulates candidate campaigning, raising funds, giving speeches. Good choices win points.

G28: ELEVATOR. You're at the bottom of series of elevator shafts. Try to reach top without getting clobbered by elevator.

G29: ELI*. Animated Cartoon depicting the adventures of Eli.

G30: ELIZA. Classic Psychiatrist game where the computer counsels you. Compiled version.

G31: ENCOUNTE*. Space encounter of the unfriendly kind. Good battle.

G32: ENTRAP. Othello board-type game, cleverly designed, good graphics.

G33: FIRE. Forest fire is raging and you have limited resources to combat. Will you lose the forest? What is your strategy?

G34: FLIGHTMARE. You are pilot for Omegans against marauding vandals.

G35: FOOTBALL*. Tactical play in a footy simulation.

G36: FORTUNE. Wheel of Fortune. Spin the wheel and win prizes or be penalised. More than one can play.

G37: FROG. Frog tries to cross road to safety and avoid being splattered by traffic.

G38: FUN*. Fun with numbers. It helps to understand a little algebra to solve the problems.

G39: GEOGRAPHY. Educational game that tests you on cities, capitals, countries, etc.

G40: PC-GOLF. Very well presented. Takes into account handicaps, clubs, swing, choice of 3 courses.

G41: GRIME. Hi-res fight against those nasty grimes that threaten to attack and overwhelm.

G42: HANGMAN*. Correctly spell the mystery word before the computer hangs your image.

G43: HANOI*. Transfer disks from one pile to another. Requires thought.

G44: HOBBIT*. Adventure. Hobbit thief tries to steal from the Wizard's castle.

G45: HORNADETTE. Adventure. Invading the Castle and find the secret formula.

G46: IBMADV. Adventure. Government agent infiltrates IBM headquarters.

G47: IQUEEN*. Board game based on chess and using only queens.

G48: JUMPJOE. Mad robots chase Joe through rooms and past obstacles on space station.

G49: KONG. Climb the structure against falling objects and other dangers.

G50: LANDER*. Try to land a spacecraft against gravity, adjusting rocket thrust. Good sound and graphics.

G51: LANDMINE. The enemy has buried mines and you have to reach headquarters — preferably intact.

G52: LIFE2. Enter details of bacteria colonies and they breed, generating patterns of the screen.

G53: LOCUST. Spreadsheet setting. Kill the numbers, zero a column to win. They keep growing!

G54: MARS ESCAPE*. Adventure. Your mission is to escape from Mars.

G55: MAZE1. Mazes with different degrees of difficulty. Good graphics.

G56: METEOR*. Erase solid blocks before the constantly falling meteors hit you.

G57: MEMBRANE*. Chemistry game. You are a cell membrane. Learn about cell behaviour.

G58: MUSICIAN. Compose songs, music. Helps you to compose on the screen and play back.

G59: OIL. Offshore Drilling Simulation. Organise resources to strike oil or go broke.

G59A: PACMAN. Classic where you are in a maze hunting treasure while the monsters hunt you. Different levels of play.

G60: PANGO. Attempts to clear bees in a field by stunning or squashing with blocks.

G61: PARATROOPER. Fight off the paratroopers who keep landing until they can overwhelm.

G62: PINBALL. Good screen effects let you play this arcade type game with the cursor keys.

G63: PIRATE*. Adventure set on a pirate ship.

G64: PITFALL. Fast moving flight through valley or pit. Good screen effects. Needs fast reflexes to avoid walls and other dangers.

G65: POKER. Card game. several can play or just you against the computer.

G66: POKER MACHINE. (ONE ARMED BANDIT). Try to line up the reels for your win.

G67: POLYMAZE. Computer generates hexagonal mazes and will demonstrate how to solve them.

G68: PRESCH*. Spelling and number game for small children.

PROVOCATION PINUPS: These are intended for printing. Hang alongside last month's sales figures (or whatever).

G69: CALENDAR GIRL.
G70: JEZABEL.
G71: DAWN.
G72: DELILAH.

PROVOCATIVE SCREEN PICS: These are animated screen pictures.

G73: RECLINING NUDE.

G74: STRIP.

G75: PYRAMID. Fast moving game where you step onto cubes to avoid bouncing rocks and creatures.

G76: QBERT. Bert & the Snake. Jump from one title to another pursued by the snake and falling fruit.

G77: RACECAR*. You race the computer on racetrack controlling speed, braking, etc.

G78: RAIN. Challenging pinball game that has very good graphics and cursor control.

G79: ROCKETS. Fascinating, fast, hi-res game of space battle.

G80: ROULETTE. Gambling simulation using screen version of a roulette wheel. Cheaper than going to a real casino.

G81: SCATTER. Logic puzzle. Fire a laser to determine whereabouts of 10 atoms in a box.

G82: SEAWOLF*. Valiant submarine commander attempts to sink the invasion fleet with his torpedoes.

G83: SECRET ADVENTURE*. Create your own adventure. For small children. Answer questions about rooms and monsters and it generates a game for you.

G84: SKYTREK. Comprehensive strategy game of the Startrek type.

G85: SLOTMACHINE*. Poker Machine game that can be played by all ages. Animated.

G86: SOLITARE: Card game that shows you the draw and you work out where to place each card.

G87: SPACEWARS. Nicely presented Starwars type of game with many factors to consider.

G88: SPACEVADERS. Race across the screen shooting them down. Good graphics.

G89: STARLANE*. Interstellar Trading. Space Monopoly where you try to build an empire.

G90: STOCKMARKET. Simulation game where you try to amass your fortune in stocks and shares.

G91: SQUARE*. Like Tic Tac Toe but more combinations with dots on larger board.

G92: SUBCHASE. You're in a destroyer on patrol trying to destroy subs swarming below.

G93: SWARMS*. Attack of the killer bees! BeeWars?

G94: TANK*. Two tank commanders slug it out.

G95: TRADE*. Star trading by intergalactic merchant. The ultimate travelling salesman.

G96: WIZARD*. Adventure in the Wizard's castle against monsters, elfs, hobbits, dwarf, etc.

G97: WOMBAT*. Generates questions for mental arithmetic. Suits primary children.

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37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72
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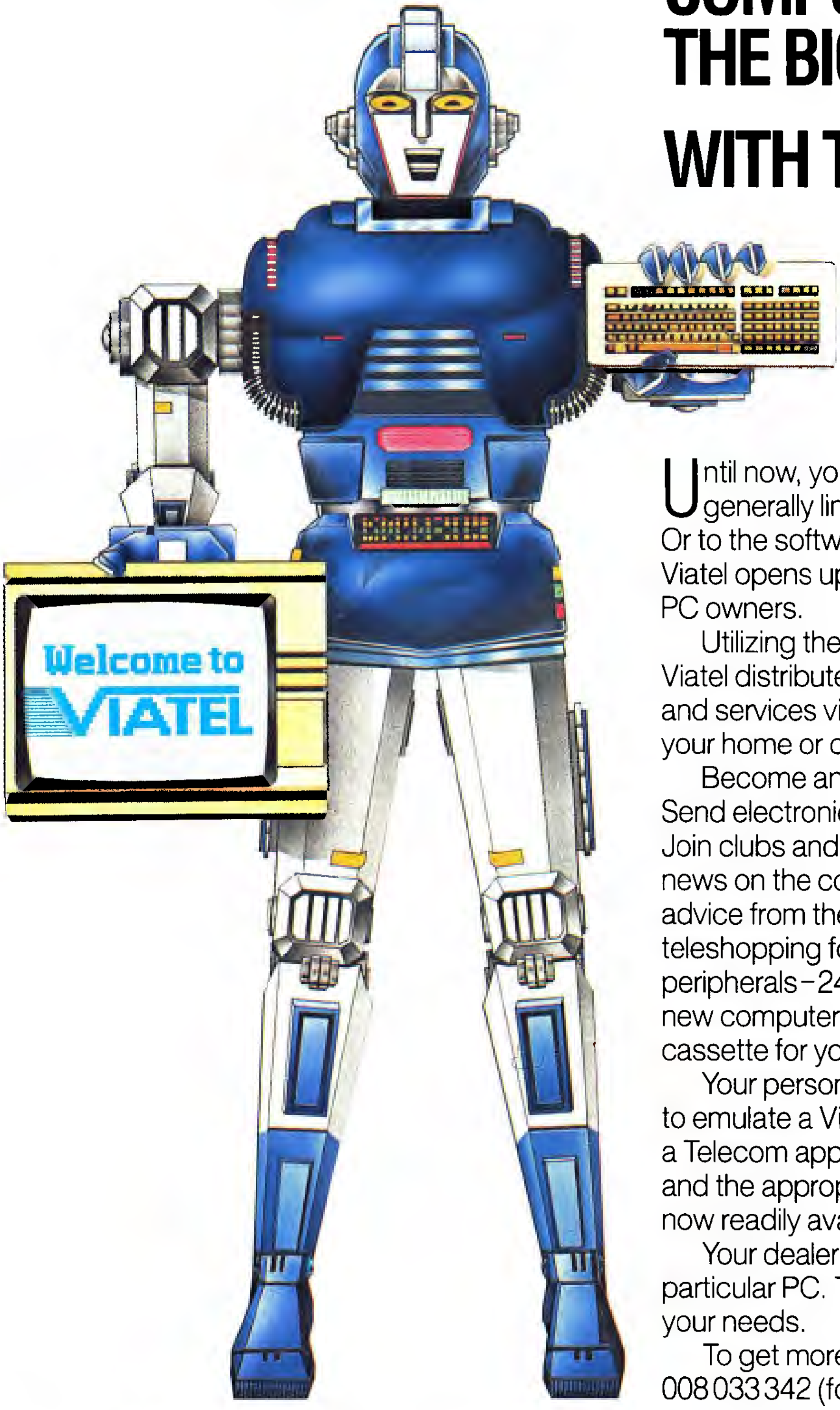

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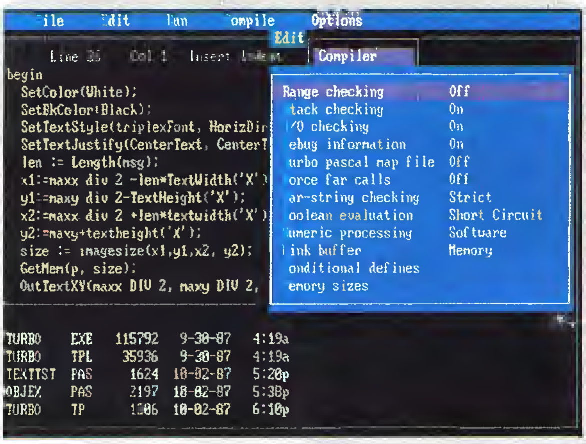
Turbo Pascal 4

It's always a problem following in the footsteps of a successful product, but Turbo Pascal version 4 from Borland has an especially difficult job on its hands. Owen Linderholm judges whether its enhancements — or failings — justify the upgrade.

The integrated environment with a Turbo 4 program loaded. The pop-up box shows the compiler options that can be altered. The Options and Compile menus allow almost everything in Turbo 4 to be configured, and configurations can be saved to disk and reloaded



```
begin
  SetColor(White);
  SetBkColor(Black);
  SetTextStyle(triplexFont, HorizDir
  SetTextJustify(CenterText, CenterT
  len := Length(msg);
  x1:=maxx div 2 -len*TextWidth('X')
  y1:=maxy div 2-TextHeight('X');
  x2:=maxx div 2 +len*textwidth('X')
  y2:=maxy+textheight('X');
  size := imagesize(x1,y1,x2, y2);
  GetMem(p, size);
  OutTextXY(maxx DIV 2, maxy DIV 2,
```

```
Range checking          Off
 tack checking          On
/O checking             On
 ebug information       On
 urbo pascal map file   Off
 orce far calls         Off
 ar-string checking     Strict
 oolean evaluation      Short Circuit
 umeric processing      Software
 ink buffer             Memory
 onditional defines
 emory sizes
```

```
TURBO    EXE   115792   9-30-87   4:19a
TURBO    TPL    35936   9-30-87   4:19a
TEXTTST  PAS     1624  10-02-87   5:20p
OBJEX    PAS     2197  10-02-87   5:38p
TURBO    TP      1306  10-02-87   6:10p
```

There are no prizes for guessing which is the computer language that revolutionised programming at the serious end of the microcomputer world — it's Turbo Pascal. It was launched only four years ago, a sign of how quickly things move in the computer world. Since that time it has sold three quarters of a million copies.

Turbo Pascal was the first PC program to succeed in the low price area and, in fact, defined the low-cost software market. No-one thought it possible to make money selling a software product so cheaply, especially when it was as good a product as anything on the market. The reasoning went: 'If it's so good, how come it's so cheap?'

Time has passed, though, and companies change with time. Recently, it was thought that Borland intended to desert the low-price market when it acquired Ansa and continued to sell Paradox at the high price of $1434. Then came rumours that the company's word processor, Sprint, would cost around $400. Does this signal an end to cheap languages? The answer is 'No'. Turbo Pascal version 4 costs about the same amount of money that Turbo Pascal version 3 did at *its* launch. Borland says that it could not get away with selling a computer language for over $250 'for the foreseeable future'.

Installation

Nothing much new to report on this front: you create a blank disk (preferably a system disk) and copy the files onto it. However, since Turbo Pascal has grown and includes several new ancillary files, you will probably only be able to fit one of the two versions of the compiler onto a single disk. The DOS world has spread considerably since Turbo 3 emerged (for example, the most popular computer among *APC* readers is some type of PC-compatible with a hard disk and at least 640k of memory), and Turbo 4 will benefit considerably from being used on hard-disk systems.

Overview

There are two versions of Turbo 4. One is a bare-bones compiler that is only accessible from the DOS prompt or via batch files. Although much cruder in visible operation, this version of the compiler is fully as powerful as the other, with its window-based environment and built-in editor. The command-line version is initiated by typing 'turbo', which prompts a list of options and filenames.

This version of the compiler is provided for those users who want Turbo 4 but only have 256k of memory, or for those who want to use a separate editor.

Most users will want to use the editor and windowing environment for the level of interactivity it allows. Since an editor is immediately available, you can correct errors with the offending source code in front of you and recompile. I found the integration of the editor and compiler in Turbo 3 so useful that it immediately became the language I preferred to program in.

User interface

Turbo 4's user interface conforms to the new Borland standard: it has a menu across the top, with windows for the editor and any other necessary sections below. Editing commands are all either based on obvious keystrokes or are faithful copies of WordStar commands — still the word processor most people know best. In addition, you can change the editing commands to whatever you like. Pop-up boxes appear bearing relevant messages whenever the program wants to convey more information to the user. Also, as usual, almost everything about the interface is configurable with regard to positioning and colour.

Everything operates very cleanly, quickly and smoothly. For example, although the editor is less powerful than a full word processor, it is also considerably quicker. One of the nicest parts of the new environment is how files are loaded. A large directory box pops up on the screen showing all the files matching whatever name you requested (the default is ' * .PAS') and you simply move the cursor to the required file and press ENTER.

Most functions of the compiler are accessed through the menus or directly via combinations of keys with ALT and CTRL.

The menus contain a lot of surprises for users of Turbo 3. Turbo 4 is probably twice as complex as Turbo 3, and that means there are a lot of unfamiliar options now available. Most of these are concerned with the expansions and changes to the language itself. The others, all features of the new Borland integrated environment, are things like onscreen help, window sizing, configuration, file operations, and so on.

The significant changes are in the language itself. The highlights are: the 64k code limit imposed by Turbo 3 can now be broken; the compiler is even faster; separate compilation is available using units (the single most important change); code generation has been improved; far better basic graphics are included; run-time error detection has been improved; '.OBJ' files can now be linked in by the linker (which, incidentally, now only links in

```
{$R-}    {Range checking off}
{$B-}    {Boolean short circuiting off}
{$S+}    {Stack checking on}
{$I+}    {I/O checking on}
{$N-}    {No numeric coprocessor}
{$M 65500,16384,655360} {Turbo 3 default stack and heap}

{$R+}
program textTest;
uses
  Crt, Dos, Graph;

var
  GraphDriver, GraphMode, Err : integer;
  MaxX, MaxY : integer;
  message:string;

procedure display(msg : string);
var
  c : char;
  p : pointer;
  size : word;
  len : word;
  x,y,x1,y1,x2, y2 : integer;
begin
  SetColor(White);
  SetBkColor(Black);
  SetTextStyle(triplexFont, HorizDir, 4);
  SetTextJustify(CenterText, CenterText);
  len := Length(msg);
  x1:=maxx div 2 -len*TextWidth('X');
  y1:=maxy div 2-TextHeight('X');
  x2:=maxx div 2 +len*textwidth('X');
  y2:=maxy+textheight('X');
  size := imagesize(x1,y1,x2, y2);
  GetMem(p, size);
  OutTextXY(maxx DIV 2, maxy DIV 2, msg);
  GetImage(x1,y1, x2, y2, p^);
  repeat
     begin
     x:=maxx div 2 - len * textwidth('X') - 60 + random(60);
     y:=maxy div 2 - textheight('X') - 100+ random(100);
     putimage(x,y,p^,XORput);
     putimage(x,y,p^,XORput);
     end
  until KeyPressed;
  FreeMem(p, size);
end;
procedure initialise;
begin
  GraphDriver := Detect;
  graphmode:=getgraphmode;
  InitGraph(GraphDriver, GraphMode, '');
  err:=graphresult;
  if err<>grok then writeln('graphics error: ',grapherrormsg(err));
  SetColor(1);
  SetBkColor(0);
  Randomize;
  MaxX := GetMaxX;
  MaxY := GetMaxY;
  cleardevice;
end;

begin
  writeln('enter message');
  readln(message);
  initialise;
  display(message);
end.
```

Listing 1 Fancy text and graphics *An example listing of a Turbo 4 graphics program. It takes a text string and prints it on the screen in a fancy Times Roman-type font, then rapidly moves copies around using the 'bit blit' operations*

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Netcomm Automodem 1234	731	858
Netcomm In Modem	299	351
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code necessary to the running of the program); project management; interactive debugging is possible using MAP files generated by Turbo 4 and a third-party symbolic debugger; and the range of data types supported has been considerably extended.

One obvious change is that Turbo 4 produces '.EXE' files rather than '.COM' files. The only significance here is that .EXE files can be larger than 64k, unlike .COM files; and that .EXE files contain some extra embedded information about themselves. Otherwise, there are no essential differences.

Pascal programmers who cut their teeth on Turbo Pascal will be unfamiliar with units. These are an intergrated part of most serious versions of Pascal and are specified in both ANSI standards and as part of the UCSD system. Essentially, a unit is a set of pre-declared constants, variables, functions and procedures that can be used by your program as if they were part of the language itself. As far as your program is concerned, using a unit requires no extra code; the linker takes care of it all. This is important since it is how the 64k limit is breached. All units are separately compiled and, when used by a program, the linker section of the Turbo 4 compiler finds the portions of code it needs from within the compiled unit and adds it on to the code compiled from the main program. This lets the size of the final program rise above 64k.

The memory model used by Turbo 4 is the same as that for Turbo 3, with the exception of units. Data can still only occupy the 64k data segment. To exceed the 64k data limit means allocating space on the heap for each new variable. This means an overhead in coding, but the heap can be up to 640k in size.

More importantly, units are a sensible way for modular parts of a program or libraries of routines to be created and used. In fact, units are very similar to modules in Modula-2. They make the language even more organised and structured. For this reason, hacker-type programmers may not like them; but what would a hacker type be doing programming in Pascal anyway? As the story goes, the only real hackers are those capable of writing all their programs directly into memory in machine code. For those who program in the real world, however, units could prove to be very useful in long-term development. Units, like modules in Modula-2, have a 'visible' declaration section listing what they contain and a 'hidden' implementation section where

```
 {THIS IS AN EXAMPLE OF SOME CODE FROM THE TURBO EDITOR TOOLBOX FOR
  VERSION 4. IT SHOWS THE USE OF UNITS AND LINKING .OBJ FILES. THE
  DOTS SHOW WHERE CODE HAS BEEN SKIPPED OUT}

 unit SInst;
 {-Fast screen writing routines for installation programs}

 interface

 uses
   Crt,                        {screen routines - standard unit}
   Dos;                        {dos calls - standard unit}

 const
   Defnorows = 25;               {Default number of rows/physical screen}
   Defnocols = 80;               {Default number of cols/physical screen}
   HiddenCursor = $2000;         {scan lines for a hidden cursor}

                                  .
                                  .

  procedure EdFastWrite(St : String; Row, Col, Attr : Word);
    {-Writes St at Row,Col in Attr (video attribute) without snow}

  procedure EdChangeAttribute(Number, Row, Col, Attr : Word);
    {-Changes Number video attributes to Attr starting at Row,Col}

                                  .
                                  .

implementation

  {$L SINST}

  procedure EdFastWrite {(St : String; Row, Col, Attr : Word)} ; external;
  procedure EdChangeAttribute {(Number, Row, Col, Attr : Word)} ; external;
  procedure EdMoveFromScreen {(var Source, Dest; Length : Word)} ; external;
  procedure EdMoveToScreen {(var Source, Dest; Length : Word)} ; external;
  procedure EdSetCursor {(ScanLines : Word)}; external;

                                  .
                                  .
                                  .

{NOW FOLLOWS SOME CODE FROM A SEPERATE FILE, SINST.ASM, WHICH PRODUCED
 THE SINST>OBJ FILE WHICH IS LINKED INTO SINST.PAS BY THE {$L SINST}
 DIRECTIVE ABOVE}


;   SINST.ASM
;   Fast screen writing routines for Editor Toolbox installation programs

DATA    SEGMENT BYTE PUBLIC

        EXTRN   ScreenAdr:WORD,PhyScrCols:WORD  ;Pascal variables
        EXTRN   RetraceMode:BYTE

DATA    ENDS

CODE    SEGMENT BYTE PUBLIC

        ASSUME  CS:CODE,DS:DATA

        PUBLIC  EdFastWrite,EdChangeAttribute
        PUBLIC  EdMoveFromScreen,EdMoveToScreen
        PUBLIC  EdSetCursor
```

Listing 2 Including different file types *This piece of code has been assembled from different places within a Turbo 4 source file and an ASM file which is to be compiled to the Turbo 4 source. It has been taken from part of the Turbo Editor Toolbox*

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the code is. Commercial companies could sell units for specific purposes and their source code would be protected.

In association with units, Borland has provided a program for maintaining libraries of units. One library, TURBO.TPL, is automatically scanned by Turbo 4 when searching for units. Initially, TURBO.TPL has the units Borland has provided as part of Turbo 4; these are the 'System', 'DOS', 'CRT', 'Printer' and 'Graph' units. You can add your own units with the TPUMOVER program, which can insert and delete units to or from libraries. You can also create separate libraries and inform Turbo 4 to look for units in them.

There are three other units in the TURBO.TPL library. These are not strictly needed by Turbo 4 but are provided to make it easier to convert Turbo 3 programs to run under Turbo 4. Conversion between the two is not necessarily an easy matter.

Graphics

Another major change to Turbo 4 is in the graphics commands. These have been completely rewritten and bear almost no resemblance to the graphics commands available in Turbo 3. This disadvantage is offset by the fact that Turbo 4's graphics commands are far more comprehensive, powerful and fast. Some of the new functions include: auto-detection of the graphics mode you are in and use of it; using CGA, MCGA, EGA, Hercules, ATT400, VGA and PC3270 graphics displays in many of their available modes (22 graphics modes in all, from 320x20 in four colours through 720x348 in two colours, up to 640x480 in 16 colours); commands for changing colours, palettes, line styles, line widths, fonts (normal, small, triplex (fancy roman), gothic and sans serif); text direction and justification; viewports and clipping; 3D boxes, fill patterns (13 including a user-defined one); 'bitblt' operations that work impressively fast; arcs, circles, ellipses, pie segments; aspect ratio; error-handling; and the usual lines and polygons. *All* of these new graphics commands are extremely fast. For an example of graphics programming (text fonts and bit blitting) see Listing 1.

The Toolboxes

The Toolboxes have all been completely rewritten for Turbo 4. Full advantage has been taken of the new features of Turbo 4 and of the advantages of units — their functionality has increased at least as much as that of Turbo 4, and in a couple of cases their size has quadrupled. Although this makes them much more useful to the programmer who wants powerful pre-written code, it also means that they aren't of much use to the low-end user. Even a double-floppy system wouldn't really be suitable for a program whose source took up over two floppies of its own, as will easily be the case with large and complex programs written using Turbo Pascal Toolboxes.

An example section of code from the Editor Toolbox is given as an example of programming with units and .OBJ files — see Listing 2. The word processor produced by the Editor Toolbox is incredibly powerful. It now has printer drivers, fonts, macros, and much more.

But, seriously . . .

Life has also been made easier for serious programmers who want to use Turbo Pascal. In version 4, they are provided with project management commands to make and build files. If you are working on a large project and have written a program using many units and include files, it can be irritating to see the compiler recompile everything when only one short file has been changed since the last compilation. The 'Make' option on the 'Compile' menu will only recompile those parts of a program that are new or have changed since the last compilation. The 'Build' option, which is similar, will do the same except that it will recompile *all* units as an intermediate level between full compilation and making a program.

In addition, it is now possible to link binary .OBJ files into your program. Turbo 4 cannot create these files itself, but will make use of Intel standard .OBJ files from any program that can create them, including the Microsoft languages and, of course, Turbo C and Turbo Prolog. Programmers can then make use of languages like C and assembler for code dependent on high speed and on the underlying hardware. The .OBJ files produced can then be used within Turbo 4. The manual is clear on the interfacing required: you will need to declare procedures to be used as external in Turbo 4, and the .OBJ files will need to have been produced with procedures and functions declared as public.

The final extension in Turbo 4 of particular interest to serious program developers is the ability to interactively debug Turbo code. In interactive debugging, it is possible to look at the source code and check the values of all variables while a program is running. The first program I saw do this was Mac Pascal, and it was a revelation. On one side of the screen was a window showing the source code listing of the program, with the current line highlighted; on the other side was a window where the program was running. In addition, you could suspend execution of the program at any time and look at the values of all variables. Execution could proceed at any speed up to about half normal, and could be cut right down to executing the next statement on command. Never was dubugging so easy.

This level of debugging (or almost) is now available for Turbo 4. However, you will need a symbolic debugger from a company other than Borland to make use of it. Turbo 4 produces extra files with debugging information embedded in them if required — these are known as TPM files. A program supplied by Borland will then convert these to MAP files, which are what the current symbolic debuggers on MS/PC-DOS machines feed on. With a

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Compile speed comparison

These tests were all performed on a Hewlett-Packard Vectra one after another. All files were taken from real applications rather than dummy test files.

Turbo 4
1273 lines took 2.8 seconds for a compile speed of 455 lines per second.

Turbo 3
978 lines took 3 seconds for a compile speed of 326 lines per second.

Turbo C
1108 lines took 7.2 seconds for a compile speed of 154 lines per second.

Comparison of code size

Turbo 4

INTMATH.EXE	2336 bytes
GO-MOKU.EXE	10576 bytes
EMPTY.EXE	1216 bytes

Turbo 3

INTMATH.COM	11550 bytes
GO-MOKU.COM	17778 bytes
EMPTY.COM	11433 bytes

Turbo C

INTMATH.EXE	5664 bytes

Benchmarks

All timings are in seconds and were produced by the given language on a Hewlett-Packard Vectra.

	Turbo 4	Turbo 3	Turbo C
Intmath	0.02	0.03	0.015
Realmath	0.80	1.40	1.50
Triglog	12.75	15.30	10.60
Textscrn	26.25	23.00	41.50
Grafscrn	1.25	1.47	—
Store (hard disk)	2.50	2.75	2.30

For a full explanation of these Benchmarks, see APC *November 1986 issue.*

program such as CodeView (the best currently available), you can then step through the program, executing it and examining variable values.

It seems a great shame that Borland, godfather of the integrated environment approach to programming, did not include a symbolic debugger as part of Turbo 4's integrated environment. Even more unfortunately, such a debugger *is* available for Turbo 3 — in fact, two are. Turbo Power produces a program called T-Debug Plus which attaches itself, parasite-like, to the Turbo 3 main menu and then performs windowed interactive tracing and debugging beautifully. A company called Turbo Smith produces a similar product. Perhaps Borland will announce a debugger for version 5.

Another addition to the compilation process is the inclusion of directives for conditional compilation. This facility lets you generate code that will, for example, make use of an 8087 if present and ignore it if not.

There have been many other changes to the language, especially to the commands and syntax, but most of them are not serious and many are simply additions. There are several new data types: short int, long int, comp (integers from –2∧63 to 2∧63-1), words (2 bytes), new real types conforming to IEEE standards — single, double and extended (only usable on systems with an 8087, as is comp), pointer and string. Some of these clear up annoying failings of Turbo 3 and others considerably extend the language. Words are particularly useful since the task of addressing hardware relies on them almost completely.

Many additional commands have been added — some to make use of the new data types, others to clear up oddities or missing functions in Turbo 3. For example, a new function, 'ReadKey', is provided to read a key from the keyboard without echo; interrupt-handling procedures are included in the DOS unit; a new procedure to execute a DOS program has been included; there are special procedures to move blocks of memory around; file and disk utilities are more extensive than in Turbo 3; there is date and time access, and 'changing functions; there's a wide range of directory management commands; and there are commands and tests for memory-mapped video displays.

Compatibility with version 3

It is obvious from all these changes that compatibility between Turbo 3 and Turbo 4 is a matter for considerable concern, and is the main reason for the extra units provided for Turbo 3 compatibility. The Turbo 3 unit covers all the basic changes and makes sure that the ordinary Turbo 3 commands will work; the Graph3 unit covers the Turbo 3 graphics commands, as these have completely changed; and the Float3 unit provides compatibility between the BCD arithmetic in Turbo 3 and the new real types in Turbo 4. These three units will make sure that practically every pure Pascal program will work, with only the addition of a line saying 'uses Turbo3, Graph3, Float3'.

However, many programmers have resorted to various tricks to get the most out of the available hardware, or have written 'sloppy' code. This kind of thing can be difficult to alter, though, especially since Turbo 4 is much stricter about type-checking. Most of these

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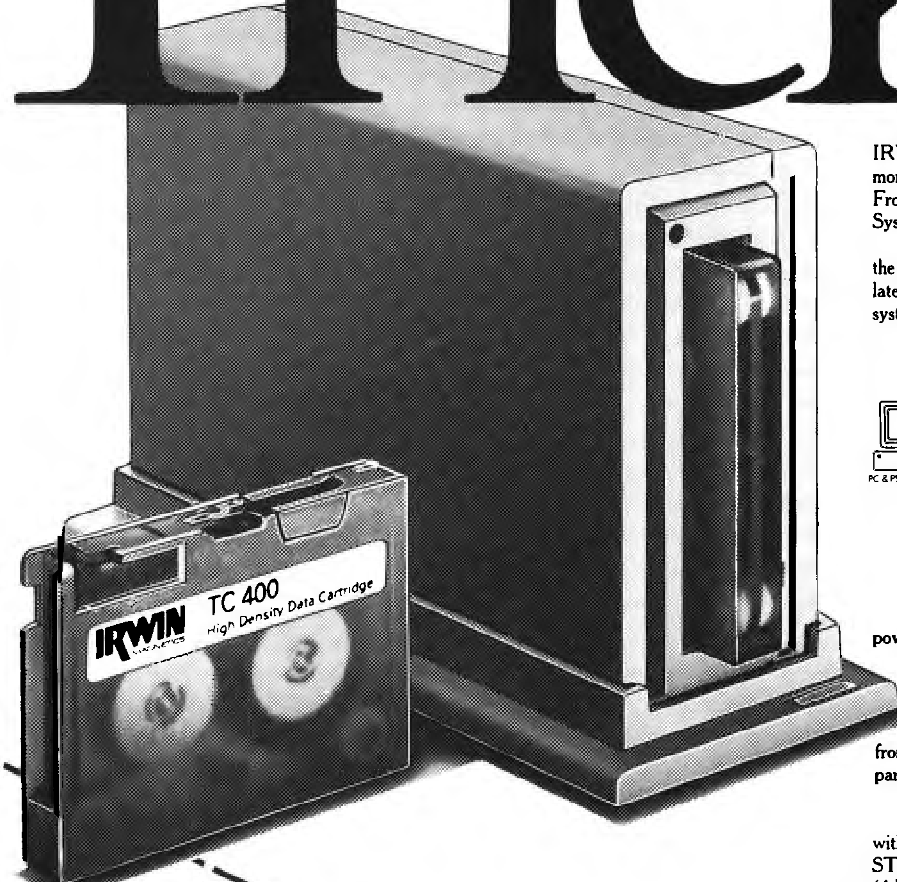

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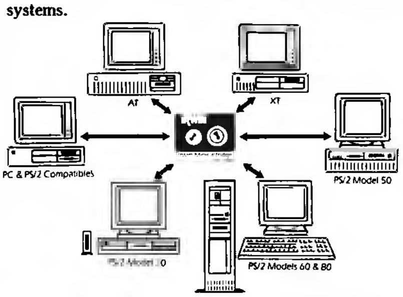

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tricks can be dealt with by a few simple modifications, guided by an upgrade program provided with Turbo 4 that automatically rewrites Turbo 3 code for Turbo 4. The upgrade program also flags any code it isn't sure about and doesn't know how to alter.

The Turbo 4 manual includes a section on converting programs. I was only able to find one piece of code which these three methods couldn't solve, and that was a piece of inline assembler which made use of system variables within Turbo 3 itself and which could only compile under Turbo Pascal 3.01a, not any other version.

Despite Borland's efforts to make conversion as pain-free as possible, it is unfortunate that such drastic changes are necessary. It is the price of necessary and welcome progress, but does it have to be quite so high? Perhaps some bright spark will come up with a perfect upgrade program.

In use

As expected, the compile speed is extremely fast. Even really large projects will compile in seconds.

I found Turbo 4's integrated environment very easy to use. Even if you object to windows, you can zoom the current window up to full-screen size. In the editor, this gives you just two fewer lines than the old Turbo 3 editor, and you get the full-screen width. In addition, the editor and its environment support the EGA 43-line and VGA 50-line modes.

I was also very impressed by the size of code produced by Turbo 4. The improvement is most noticeable in small files, but is still apparent even in large ones. An empty program consisting simply of 'BEGIN END.' (you don't need the program title) takes up 1216 bytes compared with Turbo 3's 11433. (An accompanying box gives other comparisons.)

The execution speed of the resulting code seems to have improved, especially for floating-point operations. Details of Benchmark comparisons between Turbo 4, Turbo 3 and Turbo C are shown on the previous page.

Despite the increase in size, which will upset those who can't afford to increase their RAM to 384k, Turbo 4 is still manageable on a single-disk system, although two would be better and a hard disk would be ideal.

I found it extremely easy to make Turbo 3 programs work in Turbo 4, despite the complex set of issues involved in conversion. However, getting a program to work isn't quite the same thing as getting it to work satisfactorily. If I had to optimise my programs for code size and speed, then conversion alone wouldn't be enough — a thorough rewrite would be called for.

Documentation

In the usual Borland style, the Turbo Pascal 4 documentation consists of a paper-bound book that is larger than the Turbo 3 version, reflecting the increase in the language's complexity. The contents are quite clear and well laid out, although you may need a couple of trips through the index to find what you want. The style isn't perfectly clear, but is a lot better than most computer manuals.

The manual is completely indispensable — it's the perfect method of copy protection, as you can't use a language seriously without a good reference guide.

Prices

Borland is expected to start shipping Turbo 4 internationally in about four weeks, and the Australian distributor for Borland, Tech Pacific, is hoping to have copies before Christmas. Prices have not yet been finalised, but those stated can be taken as an indication.

Turbo 4 is expected to cost approximately $225. Registered users of Turbo 3 will be able to grade to Turbo 4 for around $100, and will receive exactly the same package as they would have if they had bought it new.

The Turbo Pascal 4 Jumbo Pack includes Turbo 4, Turbo Tutor for version 4, Turbo Database, Editor, Graphics, Numerical Methods and Gameworks Toolboxes (all upgraded for version 4), and will cost approximately $790, quite a jump from the current Turbo 3 Jumbo Pack which currently sells for $479. An upgrade for the Pack will be made available (no price available), and it will also be possible to upgrade programs from the Jumbo Pack individually, if you don't own the whole Pack. Prices for these will vary, and no prices were available at the time of going to press.

Borland is continuing to sell and support Turbo 3 for CP/M and generic MS-DOS computers, but PC/MS-DOS sales and support will also be continued for those who don't want to upgrade.

Conclusion

Turbo 4 is a significant advance on Turbo 3. The problem is that Turbo 3 is a worldwide established product with three quarters of a million registered users — and probably the same again with pirated copies — and people don't like change.

The compatibility issue is bound to cause concern but it shouldn't. Firstly, 95 per cent of programs will run immediately after a pass through the upgrade program. Secondly, Turbo 4 offers a significant increase in power for not much more in price, or $100 if you are upgrading. Finally, Borland won't object if you continue to use both version 3 and version 4 — just don't expect your version 3 programs to work with any new Borland developments.

However, I have my doubts about a few of the new features, and I am disappointed that Borland didn't see fit to include an interactive or symbolic debugger.

The pricing is pretty much as expected, and there are some good features to entice those upgrading from Turbo 3. As Turbo 3 is still being supported, you will have to make the decision whether or not to upgrade. Personally, I feel that upgrading is essential if only because of the additional power of Turbo 4. For people starting out with Turbo Pascal, there's no excuse. The best bargain in programming software is now even better value.

END

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Alan Kay: face values

Alan Kay has had a profound influence on the microcomputer user interface. Mice, icons, windows and the Smalltalk programming language can all be attributed to the team he led at Xerox PARC in the 1970s. Robin Webster talks to him about his work, from those early days at Xerox and the creation of the Apple Macintosh to his current work with software fish-tanks!

Consider the magician's top hat . . . is it not one of the most singular user interfaces ever? The magician only need reach in and retrieve whatever he wishes, whether it is a bunch of flowers or a rabbit. While its operation may be mystical, its purpose is readily apprehended.

In many senses, software developers are striving to emulate that top hat, to find a delicate balance between power and ease of operation that will open up the potential of the computer to everyone without demanding too great a price.

Personality

One of the most imaginative and influential computer scientists involved in shaping the ways in which people interact with computers is Alan Kay. Now an Apple Fellow with Apple Computer in California, Kay is best known for his early work at Xerox's Palo Alto Research Centre (PARC) on the Smalltalk language and the notion of the Dynabook computer.

Although Kay intended the Dynabook (refer to the Dynamac Benchtest, APC February 1987) to take a number of forms, the most famous is the notebook-sized version which would have a full-page graphics display capable of mimicing paper and ink in its clarity, and a variety of processors to provide the power to handle sophisticated computing tasks.

So what happened? Why don't we have a Dynabook today?

"Well, my timetable for the Dynabook was 1982," said Kay. "It wasn't just a hope, though, I really expected that it would be a reality by then. Many of the technologies and concepts required to make the Dynabook possible were already in place or easily predictable.

"For example, Gordon Moore, one of the guys who started Intel, wrote a paper way back then predicting what would happen with silicon. Basically, he said here's what the physics of silicon is when you are trying to make transistors from it, and here's what happens when you try to go smaller and smaller as far as power and speed and so on . . . he drew this curve that extends into the year 2000 and shows the kind of progress to expect — in 22 years he's only been off by about 5 per cent.

"Personally, I was off by about five years in predicting the flat display screen because I had no idea American industry would just drop the technology so that we would have to wait for the Japanese to move in and take that particular business over . . . The one technology I was completely wrong about was magnetic bubbles — I certainly haven't been able to figure out whether it is inherently a bad idea or whether there are just a thousand times more people working on CMOS technology."

The fact that the Dynabook remains an unfulfilled area is only one symptom of what Kay sees as a fundamental problem in the way computer developments take place today.

"I started programming in 1969 and so it always makes me smile a little when I see the hyperbole used in computer magazines to describe things that were actually first done years ago," said Kay.

"Whenever I give a talk, I often start by saying that there really was life in the 60s and that many of the seminal ideas we are still trying to work out are due to people from that time. People back then had a more complete vision of what a computer system should be able to do. There's a real problem with trying to have a complete vision today because of the urgency to go out and get people to buy something — there's no effort to think it through all the way. In the 60s, people who worked on design projects were true believers. They actually cared about what the product was and what it could do. There are a few people like that today, but most are trying to make a quick buck.

"A good example is that you can't find a user interface that is more advanced in terms of qualitative features than the one we designed 15 years ago at Xerox PARC with windows and all that stuff. The point is that there have been 15 years to invent something else. I would claim that the rise of PCs has formed a sort of Gresham's Law . . . you know, Gresham's Law is that the bad money drives out the good. Therefore, it's easier to do bad software than good software."

A major reason for mediocre software is that most developers are not willing to face up to the immense amount of incubation that it requires to turn a good idea into a good product, says Kay.

"Consider that the first wave of stuff at Apple was really built on the shoulders of many PhDs who figured out how to produce silicon chips, and that the second save of stuff from Apple (the Lisa and Macintosh

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products) was built on probably $US100 million worth of development by Xerox.

"In the 60s, you had basically 10 or 15 people who were personally involved in most of the major advances in computing. There's Ivan Sutherland, for example, who was the developer of computer graphics as we know it today — that is, interactive computer graphics. Twenty-five years ago, Ivan started working at MIT on something called Sketchpad. All his work was done on a machine the size of a gymnasium which was slightly less powerful than a 512k Macintosh. Nevertheless, Ivan believed that the pictures on the screen should be a representation of some meaningful structure inside, and so Sketchpad was the first object-orientated programming system: it had objects, instances, and classes.

"There is no graphics system today that runs as well as Sketchpad did 25 years ago — there's no question about that. Also, if you look at today's spreadsheets, they provide just a glimmering of what Sketchpad could do. Sketchpad could solve simultaneous on-linear problems that involved many iterations of something — most spreadsheets can't even solve problems that have any kind of circular relations in them at all."

Nothing new

Kay even rejects the idea that the in-vogue concept of hypertext — as typified by products such as Bill Atkinson's HyperCard (see review in this issue) — is new.

> *"There's a real problem with trying to have a complete vision today because of the urgency to go out and get people to buy something . . ."*

"There was a system called NLS in the mid 60s in many ways every bit as good as HyperCard," he said. "NLS was developed by Doug Engelbart and it was the first living hypertext system. Furthermore, you could do group collaboration with it, which none of today's systems can do.

Nevertheless, Kay believes that the HyperCard will have a major impact on the way people get things done with computers.

"The hardest thing about giving people building blocks is deciding how much architecture you should build in. Smalltalk was very successful because some of the systems level architecture was provided so that you had to go to enormous lengths not to do something the way Smalltalk wanted you to."

"The same thing is true about HyperCard — although we don't even call it programming. It's called scripting instead. Basically, HyperCard forces people to do object-orientated programming for the first time ever. The reason the scripting language was called Hypertalk is that a lot of the ideas came from the early Smalltalk, although, paradoxically, it is less complete.

"While HyperCard has some flaws, the flaws are far outweighed by the fact that the context is so powerful it lowers the threshold for programming," added Kay. "It's much closer to what I have in mind."

Generally, Kay is not too impressed with the kind of hardware that is avail-

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able today, though he admits to being fairly well-disposed towards the new Macintosh II system.

"Well, lets put it this way. When the first Macintosh came out I said that it was the first personal computer good enough to be criticised. And now, in my opinion, the Macintosh II is the first microcomputer that's actually good. Mind you, it's still a subset of the stuff we did at PARC — it takes us to about the level we reached at Xerox in 1978–1980, something like that.

"I really think that things could have gone a lot more smoothly with regards to computer hardware. I was once quoted, correctly, as saying that 8-bit micros are no good, and I was right, even though I was criticised for saying it at the time. There's nothing like 80 million of those things out there, is there?

"The micros that everybody will be using in the future are going to have exactly the specifications I predicted almost 20 years ago because it's a trivial prediction. All you have to do is ask how fast the human nervous system is and how faster again do you need a computer system to be before it is both fast enough and high level enough to be useful?"

Foundation

Kay points to the late 60s and early 70s as being a very important time for him, a time when his perceptions of computing were altered by a series of key, and sometimes unlikely, events.

"I was at the University of Utah in the late 60s and got a consulting job at an aerospace radar company with a guy called Ed Cheadle. Together we developed something called the Flex machine. It had an object-orientated language, called Flex, that actually repelled users when we tried it on them. It was a little bit too much like dealing with APL, even though it was extremely powerful. There were just too many commands to learn.

"It was then that I realised that graduate students were really bad at designing user interfaces, since part of the puberty rite of being a graduate student is proving you can deal with systems that have 500 lousy commands, just for the sake of it.

"It was just shortly afterwards that a number of things happened. I became aware of Seymour Papert's work with children and the Logo language, and that gave me a completely different perspective. The kids weren't faking, they really were using the language to do things, even if it was only creating effects. I said to myself, boy, you should never design a computer system that children can't use. That became a total rule and I've never designed a system since that wasn't designed for children first.

"I also started reading McLuhan and there was the realisation that computers were a type of media and not tools. This was just the opposite to what I had been thinking, it was unbelievable."

Armed with these new perspectives, Kay then tried to figure out his next step.

"One of the best things about getting interested in how children might use computers was that it got me to read books I would never have read before — books by authors like Piaget and Bruner. I didn't get much inspiration from Piaget, but Bruner was really amazing. If you want to design a user interface you should read his book *Towards a Theory of Instruction*; it is quite remarkable.

"Basically, he was saying that there were three very different ways of apprehending the world: a muscular, or enactive stage; an iconic stage; and a symbolic stage."

Now, about 1972, Kay published his first paper at Xerox on the Dynabook concept. It was only three years later than he chanced upon what he calls 'the missing link' between all the different ideas he had collected up to that time.

"We were trying to understand what the mouse and stylus would mean to a user, then one day I happened to be watching television when this guy called Tim Galway who wrote a book called the *End Game of Tennis*, came on.

"ABC Television didn't believe what Galway had said in his book about being able to teach anybody to play tennis and so they had challenged him to prove it. They found 35 people who had never played tennis before and then picked the worst one, who was a 55-year-old lady called Molly Groger. She was 40 pounds overweight and had not exercised in 20 years.

"They put live television cameras on Galway and said you have 20 minutes to teach her tennis, and he did. He got her to play a set of tennis after 20 minutes of instruction. I went bananas when I saw that and immediately went out and got a copy of the book. It was full of great stuff.

"I realised then that one of the things you get out of giving somebody a pointing device is that you energise their enactive mentality . . . the kinesthetic senses of the body . . . the body knows where it is and where things are in relation to it.

"As far as icons are concerned they had been around since the late 1960s. Icons are basically used for memory. There are two strong characteristics about the iconic memory: one is that it is basically a bulletin board, which means that you have a number of things in the same field at one time; and the other is its incredible ability to remember images. There was an experiment done in which 25 people were showed 10,000 images spaced ten seconds apart. Even after a month, all 25 people had better than 90 per cent recall in terms of being able to say whether they had seen an image before. They could even identify many images despite the fact that they were partially covered.

"The third stage of apprehending the world, the symbolic stage, is the slightly more sinister one of the three, because it is very good for creativity and that means it is also alchemical. It is with this way of thinking that what you might call 'strange associations' are possible. This is where things are not really two sides of the same coin — black and white, good and evil — become fused. There is a wonderful book written about the turn of the century which showed that, regardless of religion, all primitive societies around the world have basically the same rules of magic.

"The author was an early anthropologist and he was trying to say that this shows there is something deep and elemental about the way the human mind works. It is kind of interesting if you think about science in these terms since science is magic with some power thrown in and what we do

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with a mathematical model is exactly what a person in a more primitive society is trying to do with a voodoo doll. They are trying to make something they can manipulate, and which will in turn manipulate the external world."

Halted progress

In terms of the ways in which computers are used today, Kay believes that most people are more or less treading water.

"We're using computers today just like we use a pencil," he said. "We're just making marks and looking at marks. Most of the content is just paper content, even with the fancy windows and other kinds of embellishments. Not only that, it's semi-literate paper content in that users are not expected to be able to do any creation of tools for themselves. It's like teaching a bunch of people to read just a little bit and then giving them comic books."

Despite the slow progress of the Dynabook, and his general contemptuousness, Kay talks hopefully about new technologies that may yet be featured on the device when it appears.

"I suppose if Xerox had become really interested in the idea, we could have had a flat-panel display of the type I described by 1980/1981. The reason I say this is that Xerox has an outstanding technology for making flat screens — it isn't a liquid crystal display, but something called a particle migration display.

"Five years from now this technology will replace all the liquid crystal displays because it looks essentially like paper. The surface of the display consists of tiny glass spheres that scatter the light evenly, and the contrast ratio is about 40:1 compared to the usual 10:12:1 you get with liquid crystals. But it's important to realise that in the labs in Japan right now are liquid crystal displays that are good enough for a Dynabook.

"Of course, the other way to do Dynabook today is to have it the size of your Sony tape recorder and have a head-mounted display. Not with CRT monitors, but with imagings on a silicon chip, which is easy to do.

"In fact, I predict that silicon-based displays will be a dominant display system over the next 15 years. The reason for that is that there are some very nice sensors for tracking head motion. So now you are sitting in an aeroplane and you have a display that is the size of your entire visual field and is entirely private to you. That display is very technically possible and is almost certainly going to happen.

"McDonnell Douglas has been working on an even more ambitious, head-mounted system which is called a variable acuity display. This is based on the idea that you are legally blind outside of a two by three degree field. So, if you put a number of pixels in the right place on a person's retina, you can give them a subjective sensation of infinite resolution — in fact, it could be something like a million pixels concentrated in one spot. The idea is that when the eye moves, the device that is shining the pixels in there has to move with it and so it always keeps the pixels on the same area of the fovea. The size of your fovea is about the size of the end of your finger at normal viewing distance . . . you put a million pixels in there and you really think it is high resolution."

> *"We're using computers today just like we use a pencil . . . We're just making marks and looking at marks. Most of the content is just paper content, even with the fancy windows . . ."*

Will this kind of display system mean that we no longer need such artefacts as windows?

"That's right, windows will no longer be needed for their space-saving attributes. Instead, windows might be used as a method of navigating around the extremely large viewing area available to you. It's worth remembering that the drawing area on the old Sketchpad system was a third of a mile on each side."

Current projects

Nowadays, as an Apple Fellow, Kay has the freedom to develop his own projects. Currently he is working on an AI-orientated project based in a Los Angeles public school where children as young as five years old are learning how to use Macintosh computers.

"My new project is called the Vivarium, an honest Latin word that basically means a protective enclosure for all living things. It came out of another person's idea, Ann Merriam, who worked for me when I was at Atari. For a while there we were working on interactive movies, the concept of creating movies you get involved with in some particular way.

"One of the questions raised was whether we could do semi-intelligent cartoon characters because Warners owned Atari and Warners also owned the *Bugs Bunny* cartoons. In the midst of all this stuff Ann Merriam was stubbornly thinking about something else. She had made many proposals before I finally got the idea which was: 'Wouldn't it be interesting to do something where the characters aren't very intelligent by themselves, but in which the whole conglomeration of them is fascinating.'

"So she came up with the idea of something she called the 'Aquarium', the idea being that you let children build their own animals such as little fish. These fish would not have more intelligence than a fish would have, but they would interact and go off and seek food and carry out realistic actions. The fascination of them would be like the fascination of an aquarium. When I finally got the idea I got very excited and worked on it a little bit, then Atari went down the tubes.

"Then in 1985, about a year after I joined Apple, I visited a school called the Open School near when I live in Los Angeles. It is really the most wonderful public school I've ever seen and it was interesting because the teaching process was so good that they didn't need computers: I thought this is a place where we could really do the aquarium project . . . a school that doesn't need to be fixed.

"Although Anne had gone to Hewlett-Packard I thought about the idea for a while and eventually raised it up from an aquarium to a vivarium — it wouldn't just be for fish, but for all types of creatures."

Kay took the idea to Apple chairman John Sculley and the Apple board for approval. He got an immediate go-ahead.

"I immediately called up Ann and she's now running the project. We've been in the school for about a year. At Xerox PARC the context of our work was what if everybody had a Dynabook? What could they do with it? The two main things we chose to work on at my group at PARC were access literacy (the equivalent of reading a book) and creative literacy (the equivalent of writing an essay).

"The children involved in the Smalltalk project were an important key to the context, because designing

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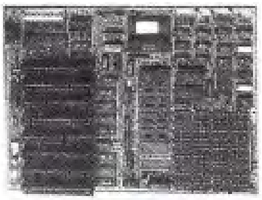

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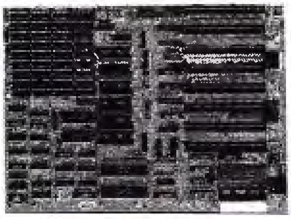

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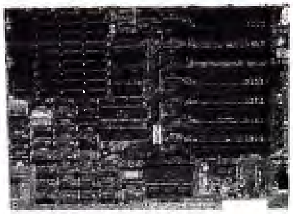

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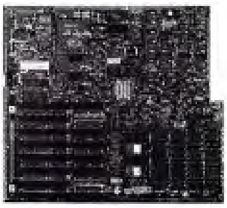

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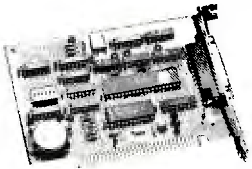

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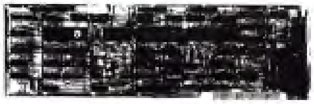

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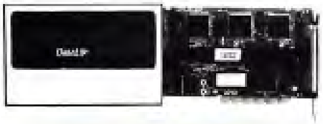

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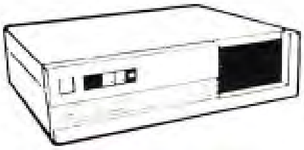

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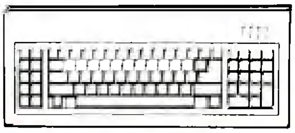

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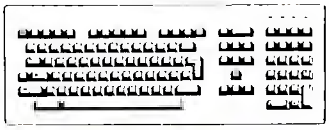

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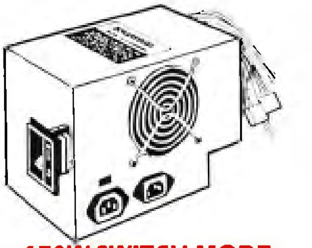

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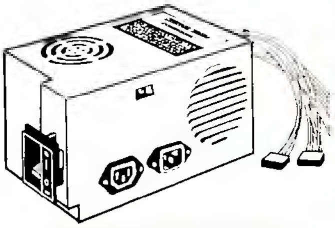

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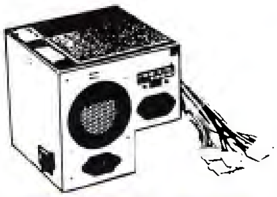

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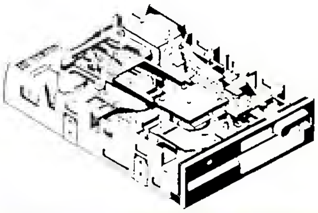

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for them made you think of a rule that simple things must be simple and complex things must be possible. The context in the Vivarium is: 'What would it be like for people to do their own artificial intelligence programming?' We're really talking about end-user AI. What would it be like to create your own intelligent agents: semi-intelligent entities that take on your goal structure — that go off and do things? You may not see them more than a few per cent at a time, but that's because they are acting according to the constraints you've applied to them."

Intelligent agents, in terms of the Vivarium project, are user-created characters that exist only within the confines of the computer software being used. The purpose of these agents is not clear cut: they may be used to just stimulate the ways in which various creatures might behave in isolation and in groups, or they may eventually be sophisticated enough to do the users' bidding, such as retrieving information from a database.

At this point, though, Kay stresses that virtually all the work taking place at the Open School, using hundreds of Apple-donated Macintosh systems, is exploratory and that there are no really specific goals that must be met.

"It's a six-year project and we're really just getting started. It's very hard to think about what an agent might be, what would it be for children, and how to go about defining one. The Vivarium has been set up as a forcing, catalytic project where we're saying we are going to teach very young children — from grades 1–6 — about animal behaviour."

Currently, the children at the Open School are using readily available Macintosh programs such as Videoworks and HyperCard with laserdisc systems to create frame by frame animations of aquatic life forms in their underwater domains.

Kay, in the meantime, is working on the special software that will be needed to more fully implement the concept of intelligent agents. As a first approach, he is using a state-of-the-art flight simulator system produced by Evans and Sutherland (a company co-founded by Ivan Sutherland of Sketchpad fame), as a providing ground for some Vivarium interface design concepts.

"Right now, we're busy figuring out first how we might go about creating agents ourselves," he said. "With the flight simulator we are able to generate 3D graphics with lots of scene details at 60 frames per second in real time. What we've been looking for here is a visual style, something like Walt Disney's *Fantasia*, that has pastel colour animation." Kay has videotapes of these early 3D explorations that suggest the extraordinary potential of the Vivarium project.

"Here's a first pass we made at the idea," said Kay, while showing a tape of two shark-like creatures swimming undersea. "This represents a thousand miles of Queensland's Barrier Reef, and these are artificial beings, generated in real-time, that we were able to define over one weekend. Basically, nobody has done this kind of thing in 3D graphics yet, so we have to solve a bunch of adult problems. We're working entirely in real time to keep ourselves honest because you can do arbitrarily good-looking things in non-real time . . .

"What you have to realise about all these flight simulator-based tests is that they are just tests. During our Smalltalk work we didn't give children a Mac Draw program to work with, they created Mac Draw applications of their own. Similarly, we're not going to give the children any of this flight simulator stuff. Instead, our job is to take the work that we adults have done and come up with a user interface and a new kind of programming language that will allow the children to come up with similar results in a matter of hours rather than weeks. They will program not only the graphics, but also the intelligence, the brains of the animals."

The way forward

Although Kay resisted speculating about any really specific end results of the Vivarium project, he did give an inkling of the kind of applications that could emerge from it.

"Eventually, when this stuff is sophisticated enough, the children will be able to turn their artificial animals into agents that can actually carry out tasks for them . . . creatures may be intelligent enough not only to be taught a particular task, but to deal with a task when it becomes intractable.

"An example of one agent I designed in the past is Newspeek that is at the Media Lab at MIT. Newspeek is an agent that stays up all night reading a dozen or so different news sources trying to put together a personal newspaper for you to read at breakfast.

"In a research project like Vivarium, though, you can't look for or worry about goals, you can only look for directions. And that's what we are doing, looking for directions . . ."

END

AST's Mac286

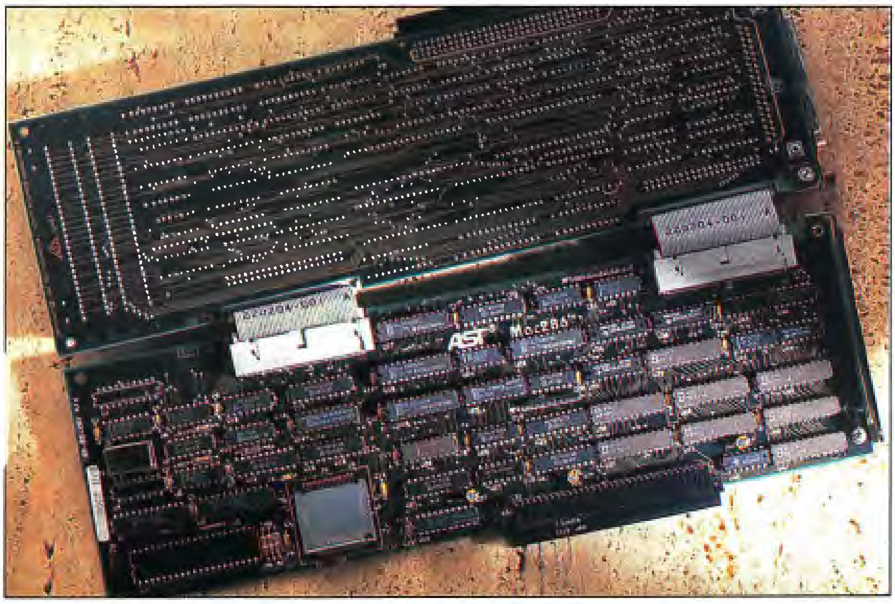
AST's Mac286 board for the Macintosh II gives a starring AT role, but fails miserably in the screen test. Rusel DeMaria checks it out.

With its introduction this year, Apple's Macintosh II represents the first open-architecture Macintosh and only the second open-architecture system from Apple since the introduction of its Apple II Plus. The other was the IIGS. With its fast 68020 processor and NuBus interface, the Macintosh II promises to be a powerful and expandable machine.

One of the first add-in boards announced for the Macintosh II was the Mac286, from AST Research. The Mac286, a plug-in coprocessing unit designed to emulate an AT-class PC, was only recently shipped after a long wait.

The Mac286 comprises two NuBus cards connected to a ribbon cable, plus all of the software necessary for its operation. The two cards effectively contain an entire 80286 motherboard, with special emulation software for various video modes, 640k of available RAM and the ability to share input/output (I/O) devices, including the Macintosh II display.

The board offers Hercules, Monochrome and Colour Graphics Adaptor (CGA) emulations on both the monochrome and colour versions of the Macintosh II displays. Although colour is supported by Mac286 on the Macintosh II red, green and blue (RGB) display, the screen-refresh rate is so sluggish that it's virtually unusable. Running in the black-and-white CGA mode is tolerable, but it doesn't compare well with the CGA mode on a true IBM or compatible. Because of these problems, monochrome text mode seems the preferred method for operating the Mac286; AST officials say that updated and improved video software will be available in the first quarter of 1988.



In other respects, the Mac286 seems comparable to many other coprocessor boards available for the PC. The 80286 CPU runs at 10MHz, with zero wait states, but the effective speed is around 8MHz, due to necessary interactions with the NuBus circuitry. Still, the unit performs benchmarks with impressive speed.

In addition to the standard hardware, the Mac286 has a slot that will accept an 80287 math coprocessor. Future options may include expanded-memory cards.

The software provides a complete component-by-component emulation of an AT on the Macintosh, plus standard 5¼in diskettes containing MS-DOS 3.2 and GW-Basic to run with the Mac286 ROM BIOS from Phoenix Technologies Ltd.

Setting up the Mac286 is not much different from setting up a brand-new PC clone. Because the unit can share the Macintosh II hard disk, it must be installed to recognise a DOS partition on that drive. This is done using standard DOS procedures — FDISK and FORMAT. During the setup phase, Mac286 requires an Apple PC 5¼in drive to run FDISK and transfer DOS to the emulated C: drive. Other floppy drive solutions may be available in the future including DaynaFile, from Dayna Communications.

The Apple drive plugs directly into one of the Mac286 cards, so it isn't necessary to purchase Apple's drive-controller card.

Of course, Mac286 may be run from a floppy only, with no hard disk emulation. Thus installed, the floppy disk is not absolutely necessary for use of the Mac286, although it remains the best means available for installing or transferring PC files and applications. In some environments, a single PC floppy might be used to install many Mac286 systems. Like any PC, the Mac286 can boot directly from its C: drive.

Mac286 operates in almost every way as a PC. It does not baulk at disk copy-protection schemes, it runs all DOS commands, and users who have DOS experience shouldn't require any retraining. Hardware-based copy-protection schemes do provide an obstacle, but, fortunately, they are rare.

A Mac286 DOS session is always started from the Macintosh in the usual manner — by double-clicking the Mac286 program icon. From there, the system operates like any standard DOS-based computer. The machine boots normally, performing a memory test, reading in environment data from any existing CONFIG.SYS file and, finally, running the AUTOEXEC.BAT file if it exists on the boot drive.

The first time the emulation software is run, it must be started from an Apple 5¼in drive containing a DOS system disk. (This is included with the Mac286 system). The next step is to create a DOS C: drive on the Macintosh II hard disk. This C: drive is actually a Macintosh file that expands to contain the DOS programs and data stored in it. However, from the DOS side it appears to be a normal C: drive. The emulation of a DOS-based hard disk is so complete that it must be created using the standard DOS utilities FDISK and FORMAT.

Although the DOS partition may be created at any size — up to the total amount of free disk space on the Macintosh II hard disk — the Macintosh file that represents the C: drive does not immediately become that large. As data is stored on the C: drive, then the C: drive file grows.

Because disk space is not immediately allocated as DOS file space, it is still available to Macintosh programs. This means that the C: drive may not be able to expand to its total partition size if some of that space is used for Macintosh files before DOS has made claim to it. In such a case, Mac286 will not write over existing Macintosh programs or data, but will return DOS 'disk full' errors instead.

To share files with the Macintosh, a special D: drive emulation is also provided. A particular folder is created on the Macintosh disk, and is subsequently identified as D: drive from within the Mac286. This folder acts as a bridge between the environments. Any file can be copied into or out of that folder from either the Macintosh Finder or the Mac286. With MultiFinder, Apple's new multi-tasking operating system for the Macintosh line, file sharing between the two environments is virtually effortless.

Memorable savings

Since Mac286 has its own 1Mbyte of address space (640k of conventional RAM, plus the remainder of the space devoted to the BIOS), it doesn't make use of Macintosh II memory for DOS. However, the emulation software necessary for operation of the Mac286 does require 640k of memory on the Macintosh II. This memory is cleared for use by Macintosh applications when the DOS emulation is exited.

> *'...computer operators who want the best of Macintosh and PC in one box, it [Mac286] is a compelling product.'*

In addition to video and drive emulation, Mac286 will emulate PC COM: ports on any valid Macintosh port. This allows use of PC communications software with equipment connected to Macintosh ports. Another emulation option allows selection between Macintosh mouse operation and Microsoft Mouse emulation for mouse-driven PC applications.

One of the simplest and most common tools on the Macintosh, the Clipboard, is functional between Macintosh applications and Mac286. This means that a textual passage from a Macintosh program such as Microsoft Word, MacWrite or Excel could be copied and pasted directly into a PC program such as Lotus 1-2-3 or WordPerfect. And the process works perfectly in reverse. However, graphics are not transferable, and ASCII characters with a value greater than 127 may not translate as expected.

An added bonus offered by Mac286 is Clipboard compatibility between PC applications. Since the Macintosh Clipboard is always functional, it is possible to cut data from one PC application and paste it into another. For instance, it is easy to cut some data from Lotus 1-2-3, then open WordPerfect or Microsoft Word and paste it in. In addition to the Clipboard, the desk-accessory (DA) menu is also available in the DOS emulation. This means that many useful DAs can be used from DOS — something a standard PC can't offer. And Software Supply's Suitcase (refer *APC* November) is completely compatible with Mac286, meaning that the supply of DAs can be virtually unlimited.

AST is billing the Mac286 as more than just a PC emulation. Given its nearly seamless operation with the Macintosh II interface, it offers solutions that are not easily achieved by purchasing a clone and placing it alongside a Macintosh.

Looking at it another way, AST officials see the Macintosh II as by far the most successful Macintosh in penetrating PC-dominated corporations. In such an environment, the Mac286 integrates systems without taking up space or causing file-transfer headaches.

The product has three potential customers. The first is the organisation in transition. More businesses than ever before are adopting the Macintosh, but managers still have a substantial investment in PC products and PC-trained personnel. For these people, the Mac286 may be an excellent transitional device.

The second class of buyer consists of people who really require PC-to-Macintosh integration — people who might use Lotus 1-2-3, for instance, to prepare data for a publication designed and produced on the Macintosh version of PageMaker. These people would need to message data frequently in PC files, then pass it on to Macintosh applications.

The third class of buyer might be the organisation whose primary computer base is Macintosh, but that has to run specific PC applications. Such a class might be an accounting firm that uses the Macintosh for almost all work, but still requires use of a PC-based auditing program until it can be ported to the Macintosh.

Is Mac286 an improvement over MacCharlie? The answer is, for the most part, yes. It does allow a greater level of disk and file sharing with the Macintosh drives. It also includes several screen-handling options, including CGA colour and Hercules Monochrome. And it is a much faster

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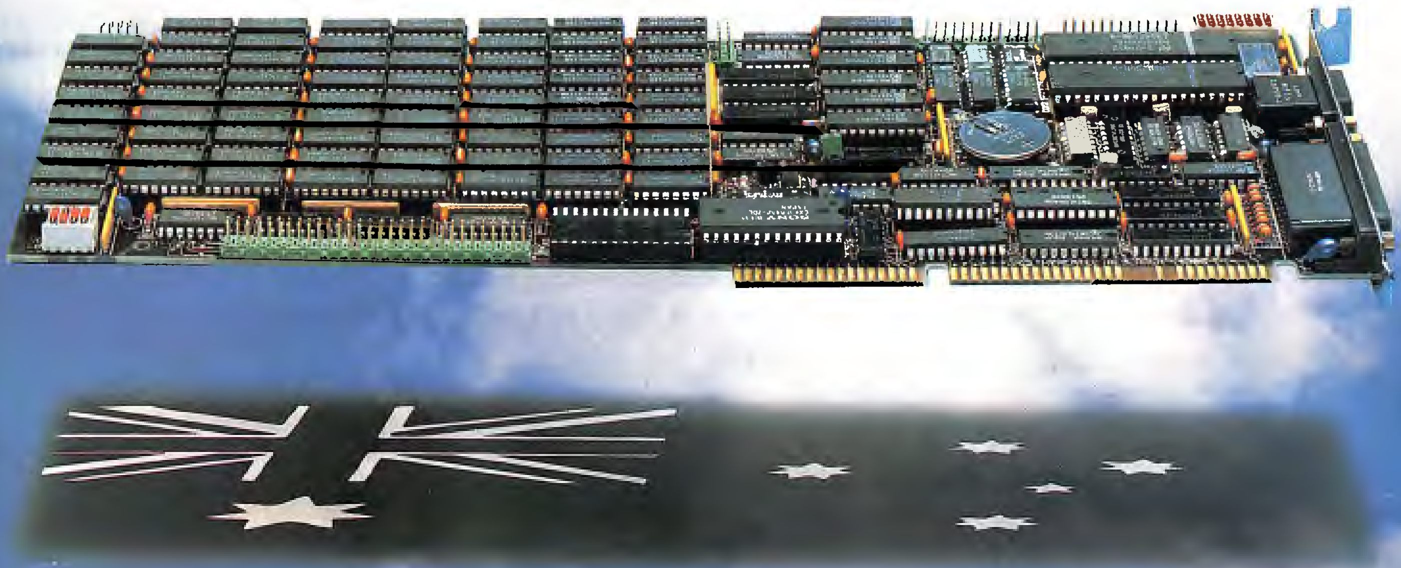

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coprocessor designed to run on Apple's flagship machine.

On the other hand, the Mac286 is priced about the same as some AT-class clones (although no additional monitor, video interface, I/O or keyboard are required). Like MacCharlie, Mac286 has no specific expansion slots either. And it also suffers from temperamental screen handling.

An imperfect marriage

Macintosh software runs very well on a Macintosh, and would, undoubtedly, run badly on a PC. Unfortunately, much of the same thing may be said about PC software running on a Macintosh. The software operates fine, but PC programs handle the screen I/O very differently from Macintosh software. The result of trying to marry the two is often irritating.

As an example, a simple directory listing results in several rounds of flickering and blanking screens before the final result is displayed and stable. This is particularly bothersome in CGA emulation. Although the Mac286 CGA emulation does display colours well, its screen handling is too irritating to be useful under most circumstances.

The COM: port emulation is good. In a test running ProComm with a 2400-baud modem, the product worked well, although the usual Procomm sound effects were missing. Among the other applications tested were products such as WordPerfect, Paradox 2.0 and Lotus 1-2-3.

Using the monochrome screen with these products was effective. With the colour screen there were too many drawbacks to make it practical. We also tried the shareware presentation manager, Present, but the results were less than satisfactory.

AST has already begun development of an updated version of the software that it claims will speed up screen handling dramatically. That release is scheduled for late 1987 or early 1988.

Other than the screen-handling problems, Mac286 is quite satisfactory. For those essentially schizophrenic computer operators who want the best of Macintosh and PC in one box, it is a compelling product. A Macintosh II with a Mac286 is no small investment, but it may meet the needs of some businesses admirably.

END

The Mac286 board costs $2994 and is available from Imagineering on (02) 697 8666.

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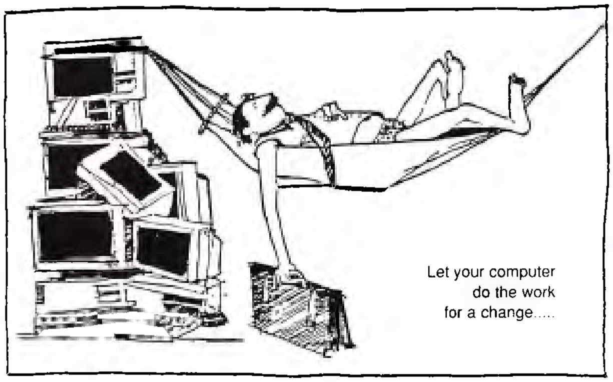

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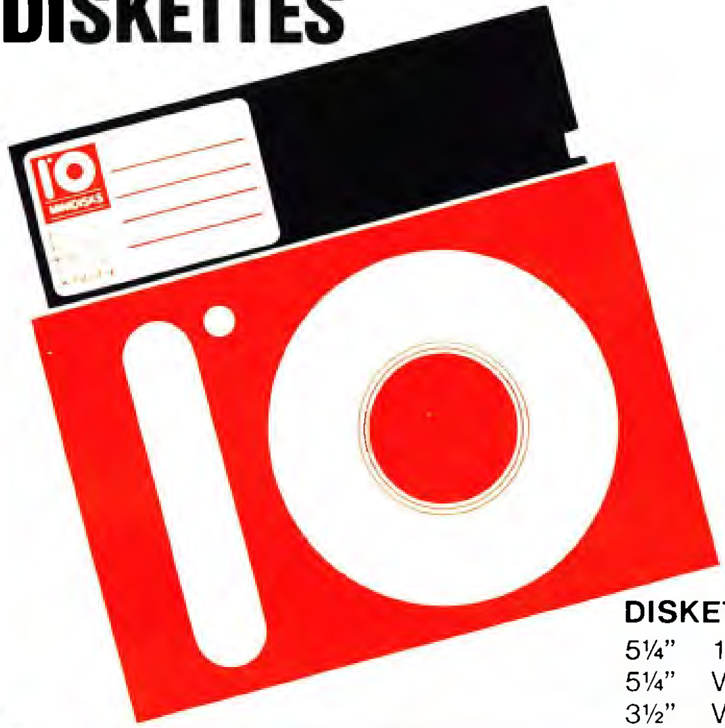

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Microtek MFAX96

The benefits of facsimile machines are beyond doubt; but how does a facsimile card added to your PC compare? Phil Cohen evaluates the Microtek MFAX96 facsimile card and finds there are some sacrifices to be made.

It seems obvious at first: you already have a PC, a modem, a laser printer and a scanner. Put them all together with the appropriate software and you have a facsimile machine. After all, that's what a facsimile machine (currently around $3000) consists of — a printer, scanner, modem and control electronics.

Unfortunately, computing wasn't meant to be easy. First, the sort of modem you might use for connection to a bulletin board is not the sort that you need for facsimile transmission. Facsimile modems for group III need to operate at 9600bps, with automatic fallback, and other things besides.

Next, you probably do not actually have a scanner (few people do).

Finally, if you are not careful you could end up using $10,000 worth of computer equipment as a dedicated facsimile machine, when you can buy a dedicated facsimile machine for $3000 and still use your computer for other things.

At first glance, a facsimile card seems like the answer to an office maiden's prayer. A facsimile card basically consists of a high-speed modem on a board which plugs into your PC, plus some software to drive the whole thing. Incoming facsimiles may be stored on disk and printed later on your laser (or dot-matrix) printer; outgoing material can be scanned and sent using the card.

It is also possible to automatically convert text files from your word processor into facsimiles, which means sending a document without it ever hitting paper. You can do the same thing with graphics, too.

And you don't have to tie your machine up to receive facsimiles, because most facsimile cards come with software which runs in the background, while you are doing other things, and will automatically receive facsimiles and store them on disk.

> *'Facsimile cards are not a means of replacing a facsimile machine, . . . '*

Even better, you can generate documents automatically and send them automatically without human intervention. For example, your invoicing program can generate invoices and send them by facsimile. Or you can generate personalised junk mail and send that to a large group of people. Or even run computerised information services which automatically collate data and send it by facsimile.

In fact, that's the real power of the facsimile card: computer-generated messages. I would go so far as to say that anyone who is thinking of buying a facsimile card instead of a facsimile machine is either very short of desk space or short on foresight.

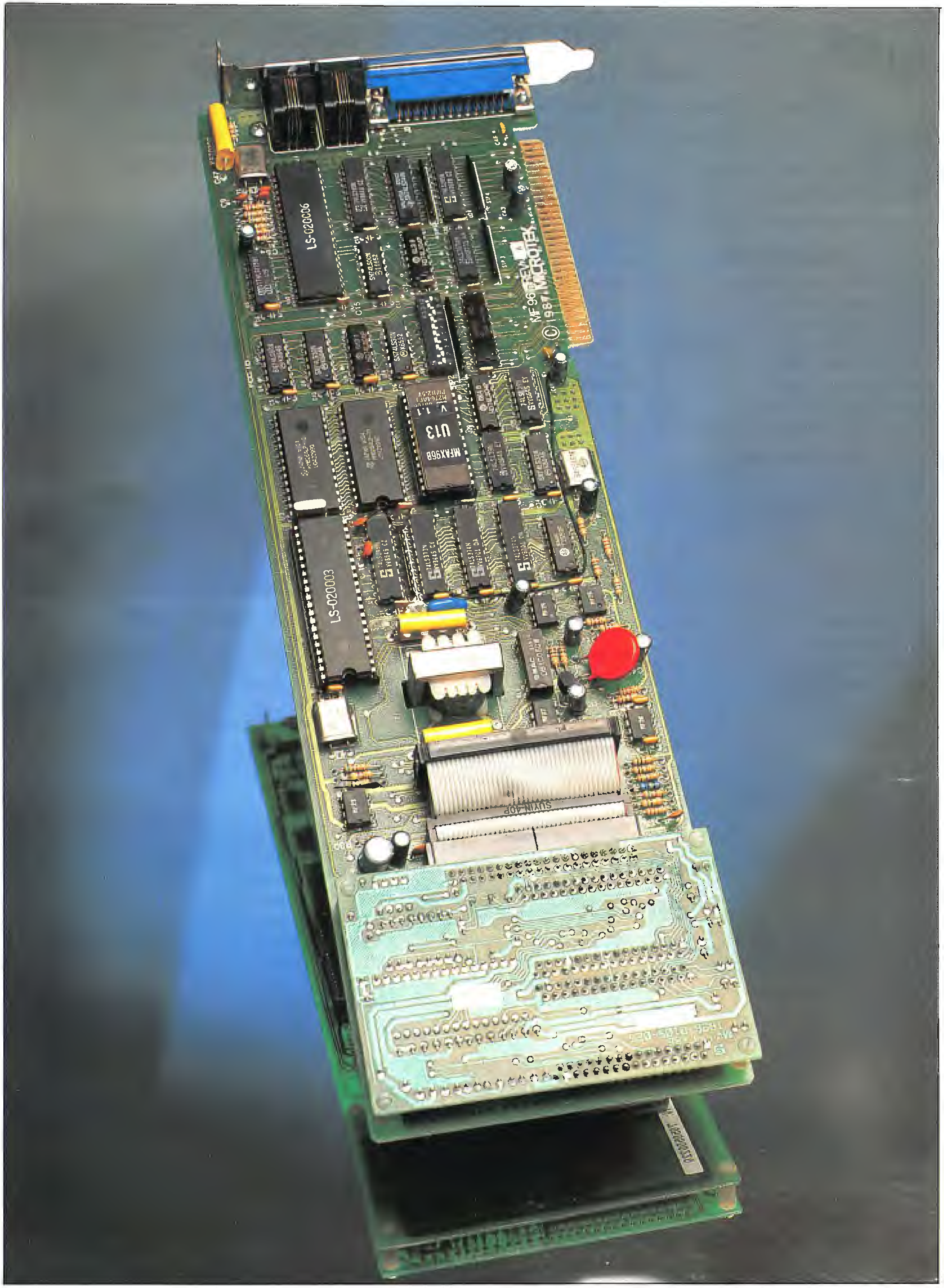
Even with the ability to scan documents using a scanner, the ability to operate in background, and the ability to capture graphics and text from disk files, a facsimile card used as a general-purpose facsimile machine is just not on. The amount of fiddle involved is just too great.

Imagine that someone in the US is going to send you a facsimile — some time this week. That means having your computer on all night, and not taking it off-line for a backup either, for a whole week.

Imagine that someone in the office wants to send an urgent facsimile on your machine — when you are in the middle of a long report printout.

Imagine that you want to send a letter with your signature on it. With a dedicated facsimile machine, you type the letter, print it out, scribble your name on the bottom and drop it into the facsimile machine. Using a facsimile card you might have to sign a blank sheet of paper, scan it, type the letter, import it into a graphics program, add your signature, convert it to a suitable graphics file type, start up the facsimile program and then send it. Sounds like too much hard work, doesn't it?

So facsimile cards are for sending automatically-generated messages, not



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for general office correspondence. Where does this leave the subject of this review, the Microtek MFAX96?

Hardware

The MFAX96 is a chunky full-length card which fits a PC or AT. There are sockets at the back for phone in and phone out connections, and a port for Microtek's own scanner (which I did not have for this review).

Along with the board you also get a phone cable suitable for the US — it has plugs to fit the US-standard phone jacks (the little square plastic ones). To use it in Australia you will need to buy adaptors.

Conspicuous by its absence was the little green Telecom sticker stating that this modem has the blessing of the authorities here (instead there was a sticker saying 'Made in Taiwan'). I assume that approval has either been granted, or will be by the time the MFAX96 hits the shops. Otherwise, as they say, use at your own risk. [Editor's note: *at the time of going to press, the MFAX96, according to its distributor, Impact Datascape, is currently undergoing Telecom approval.*]

Installation was a simple matter (but refer to the comment below about the documentation) of slipping the card into a slot.

Once inside the PC, the card is simply connected to your telephone socket and to your telephone, and you are ready to start sending or receiving facsimiles.

Software

The software which comes with the MFAX96 was a bit of a surprise: it works, and it works well. My experience with hardware products that come with a little software is that most of the design effort is spent on the former and little on the latter. Not so with the MFAX96.

The software allows you to send and receive facsimiles, of course. It also allows the control of the scanner.

Included with the software are a couple of utilities which allow the conversion of text files into image files ready for sending, and for the capture of screens of text and graphics.

And that's the first problem with the product: it uses its own image file format (which, I suspect, is just a long facsimile message in a file). There are only two ways to get something into that format without the scanner: by converting a text file, or by capturing a screenful of text or graphics.

If you want to send a full page of mixed text and graphics without the use of a scanner, the simple answer is that you can't. I suppose that you could pull it up screen by screen and capture it, but there would be no way of editing the images that you captured to remove overlaps, gaps, etc.

There is in fact a method of editing images, using a software package called EyeStar, but the only way to get your hands on that is to buy the Microtek scanner. So the facsimile card as it stands can fill pages — but only of text.

Which brings me back to my original premise: don't use a facsimile card for anything but machine-generated images, it's too much like hard work.

The user interface for the software is, however, very good, and the package has a number of very interesting features. For example, you can specify a list of facsimiles to be sent at various times during the day or night, each to different telephone numbers. This is an ideal feature if you want to send a document to many people.

The software even keeps a complete record of all incoming and outgoing calls in a file which you can examine on screen or print.

A 'view' option lets you see a facsimile file before you send it, and a fair amount of thought has gone into this section. The card will operate with Hercules, CGA or EGA standard video.

The card supports 'polling', in which one facsimile can call another and have the second send a document on request. Facsimiles can be printed to HP Laserjet, Epson FX or Cordata LP300 printers.

It is also possible to set up the MFAX96 for automatic reception and sending of messages, so that you can continue using your computer as a computer even when there might be incoming messages. The software for this is memory-resident and takes up just over 80k of your system's memory.

Finally, the software allows you to set up a telephone directory in a file, and to use the numbers in that directory for automatic dialling.

Documentation

Most of the documentation for the MFAX96 is very good. There is just one, rather critical, section which needs major and urgent rework.

The section which details the operation of the software is fairly well written, and does not seem to suffer from the Jinglish (or in this case, Chinglish) of other products developed overseas. It goes though each of the menus step by step and describes just what to do in a fairly clear manner.

However, before you start using the software you have to install the hardware, and at the top of page one of the chapter entitled 'Hardware Installation', there appears this little gem:

"The MF96B Adaptor is preset to use the following PC addresses and features: address 200 hex and the 15 addresses following it; DMA channel 1; and communications channel COM1."

Apart from the fact that the product name is wrong, to confront, what will almost certainly be, a business user with this sort of garbage at the first paragraph of page one of the manual is sheer nonsense. I can only hope that anyone buying the product will have enough sense to ask someone who knows what they are doing to install it for them.

Conclusion

The MFAX96 does what it is advertised to do: it allows you to send and receive facsimiles from a PC.

Other similar products are more flexible, in that they come complete with software which allows the user to integrate graphics and text from a number of different sources into a facsimile document before it is sent. But then again, bearing in mind my earlier comments about the uselessness of facsimile cards for general office correspondence this seems almost irrelevant.

Facsimile cards are not a means of replacing a facsimile machine, any more than voice synthesis cards are a way of replacing a telephone. The basic instrument (telephone, facsimile machine) is just too inherently flexible to be replaced by something that ties up a computer.

No, facsimile cards are a means of sending facsimiles automatically to people who, human nature being what it is, will probably not want to receive what is being sent to them; I suspect that most facsimile cards will end up sending junk mail.

Ironically, facsimile junk mail costs more to receive (in terms of the cost of the special paper for your facsimile machine) than it does to send (in terms of the phone charges). Who was it who said that it is better to send than to receive?

END

The Microtek MFAX96 PC Facsimile Card costs $2127.50, and is available from Impact Datascape on (02) 969 2699.

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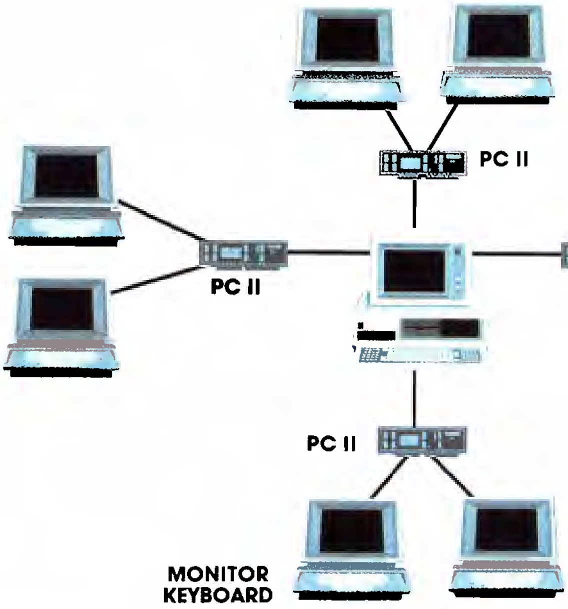

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TRADE ENQUIRIES WELCOME

EMS boards: new life for DOS

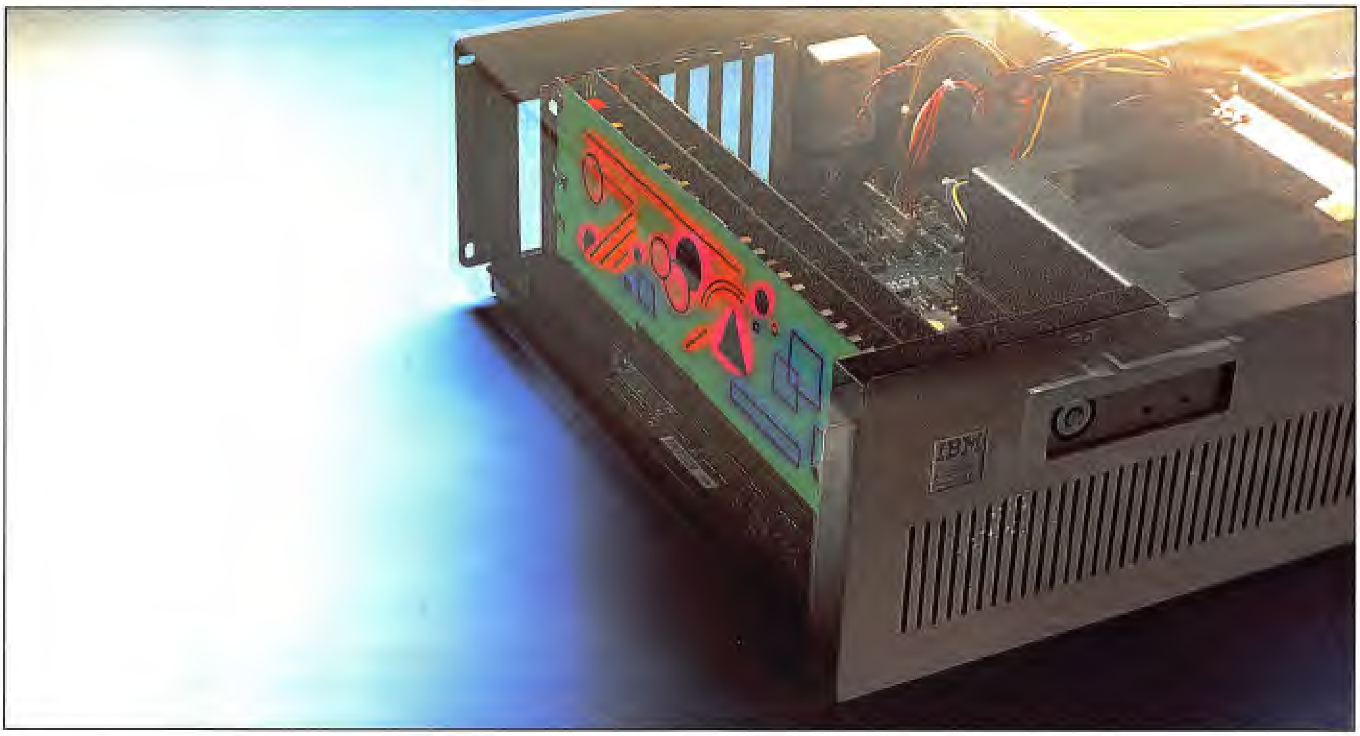
Steve Cunningham looks at the new wave of EMS boards which will allow users to stretch their add-in expectations.

The new Lotus/Intel/Microsoft Expanded-Memory Specification, LIM EMS 4.0, is breathing new life into DOS, and it could be every bit as salubrious for the fortunes of add-in memory-board manufacturers.

EMS 4.0 — which provides access to a full 32Mbytes of RAM, accepts programs of virtually any size and offers full support for multi-tasking — should further accelerate the demand for memory boards, industry experts agreed, even among users whose systems already contain a generous complement of RAM. But, to borrow a phrase, some expanded memory boards are more equal than others, especially when it comes to providing all the benefits promised by EMS 4.0.

Today's expanded-memory boards compete across a range of features, including memory capacity, ease of use and speed, all of which can influence purchasing decisions.

Beyond these considerations is a more crucial distinction, one that pertains directly to support of EMS 4.0: although all of the expanded-memory boards now on the market are at least partially compatible with EMS 4.0, many of them lack the hardware sophistication necessary to perform multi-tasking.



While new boards that fully support EMS 4.0 will eventually appear, users who want access to EMS's multi-tasking features will have to shop carefully.

"The ability to do multi-tasking with DOS programs is EMS 4.0's greatest feature," stated Dan Lucarini, marketing director of Tecmar, maker of the Captain 286 and Captain PS/30.

Mr Lucarini pointed out that a large and growing number of users are running multiple DOS programs concurrently under multi-tasking operating environments such as DESQview, published by Quarterdeck Office Systems.

"Close to half a million people right now are using DESQview, and we think that the trend towards multi-tasking is going to increase rapidly," Mr Lucarini continued. "These people are going to need EMS boards that have the hardware to do multi-tasking."

Is multi-tasking the key?

Tecmar has announced a new board product, the Captain PS/30, which supports multi-tasking under EMS 4.0 on the IBM PS/2 Micro Channel bus, Mr Lucarini said.

Of course, multi-tasking isn't the only improvement EMS 4.0 offers to veteran expanded-memory users.

For some people, other enhancements — such as the increase in accessible memory from 8Mbytes to 32Mbytes and the ability to run terminate-and-stay-resident (TSR) programs in expanded memory — are just as attractive.

Still, any buying decisions should begin with a determination of whether shoppers will need multi-tasking now or in the future. Once that judgment is made, purchasers will know whether they'll need to add multi-tasking support to the list of criteria when evaluating memory boards.

According to Gary Pope, executive vice president at Quarterdeck, only users of micros with the older PC and AT bus structures need to be concerned about multi-tasking support when purchasing an expanded-memory board.

Most boards designed for the PS/2 Micro Channel bus, and for 80386-based micros, are capable of multi-tasking, he said.

But among boards with the standard bus architecture, the gulf between those that permit multi-tasking and those that do not is formed by an old and familiar proprietary division in the marketplace.

Multi-tasking was not a feature of EMS 3.2, the standard heretofore promulgated by the Lotus/Intel-Microsoft alliance, and boards hardware engineered to support that standard alone cannot multi-task.

On the other hand, boards that are hardware-compatible with the Enhanced Expanded Memory Specification (EEMS) originated by AST Research Inc, or that have comparable circuitry, can deliver most or all of the multi-tasking benefits of EMS 4.0.

"If you're going to break the 640k barrier under DOS, you need a combined hardware and software solution," said Joseph Bentzel, vice president of marketing for Profit Systems, manufacturer of the Elite 16.

"You can write a software driver for a

That stubborn 640k limit may be history

The August announcement of the new and improved version of the expanded-memory specification (EMS) has raised hopes that the long-bemoaned DOS memory ceiling of 640k may finally have been broken.

Offering much more memory than EMS 3.2, its Lotus/Intel/Microsoft (LIM)-sponsored predecessor, supporting large DOS programs and full multi-tasking, and combining the LIM spec with AST Research's Enhanced Expanded-Memory Specification (EEMS) to serve as a unified industry standard, EMS 4.0 may make DOS a viable alternative to OS/2 for many users.

But before filling out a purchase order for a host of new expanded-memory-specification add-in memory boards, and even before evaluating specific board products, the careful buyer should study the hardware and software implications of the revamped specification.

Though industry representatives unite in singing the praises of EMS 4.0's potential benefits, they caution that uses who purchase 'EMS 4.0-compatible' memory boards won't enjoy all of those benefits automatically. In addition, they point out, owners of earlier EMS boards need only obtain a new driver to take advantage of many of the improvements offered by EMS 4.0

"All the EMS and EEMS boards already out there are capable of supporting a LIM 4.0 driver, but some are better at it than others," said Gary Pope, executive vice president of Quarterdeck.

The latest revision of Quarterdeck's DESQview operating environment, version 2.01, supports multi-tasking of large DOS programs using EMS 4.0, Mr Pope said.

If support for EMS 4.0 is not consistent throughout existing board products, users who hope to utilise all of its benefits had best become acquainted with the new specification before shopping for a memory board, he said.

The following are among the most important improvements and changes offered by EMS 4.0:

- Support for 32Mbytes, four times as much as the maximum 8Mbytes permitted with EMS 3.2. In addition, individual applications can use more memory.

According to Lotus Development Corporation's literature, a forthcoming revision of its flagship spreadsheet program, 1-2-3, will be able to use the entire 32Mbyte expanse, whereas the current version is limited to only 1.5Mbytes to 2Mbytes under EMS 3.2.

- Programs can now be written so that they execute within expanded memory. With this facility, developers could theoretically create gargantuan programs far in excess of the 640k limit they have endured under DOS until now.

In addition, this feature allows terminate-and-stay-resident (TSRs) and utilities such as 1-2-3 'add-ins' to operate by loading only a tiny kernel in conventional memory.

When activated by the user, the kernel can transfer control to the bulk of the program, located in expanded memory.

- A new function that allows software developers to write programs that utilise all types of expanded-memory hardware, including EMS, EEMS and 80386 memory, with a single programming procedure.
- Support for multi-tasking of multiple DOS programs under operating environments such as DESQview and Windows,

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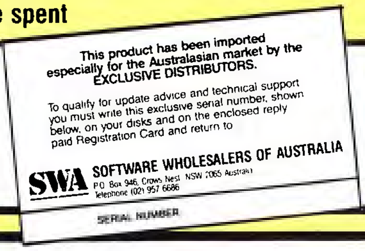

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standard EMS board, but you're only providing a subset of the features of 4.0," Mr Bentzel said. "The basic thing is, if you don't have EEMS hardware on your board, you can't do multi-tasking with it."

Profit Systems's Elite 16, includes the hardware necessary for EMS 4.0 multi-tasking, Mr Bentzel said. An EMS 4.0 driver for the board is now being completed and will soon be available, he added.

Normally, DOS programs can address only the first megabyte of memory available, Mr Bentzel explained. Under both EMS and EEMS, however, chunks of the additional RAM provided by expanded-memory boards appear to the computer as if they were located within the first megabyte of conventional memory, a process known as memory mapping.

Implementation differences

Although this basic scheme is the same in both EMS 3.2 and EEMS boards, the details of its implementation vary in several crucial ways, Mr Bentzel continued.

On a standard EMS 3.2 board, the maximum amount of RAM that can be mapped into conventional DOS memory at one time is limited by the board's hardware design to 64k. This is enough to store a sizeable collection of data, but not enough to fit a program of any significant size.

To make matters worse, EMS 3.2-compatible boards restrict the locations into which their expanded memory may be mapped to conventional memory addresses above the first 640k, Mr Bentzel said. Most of this upper conventional memory is usually already occupied by ROM routines, such as the BIOS and video-device interfaces.

The lower 640k bytes is the only block of contiguous memory much larger than 64k that is not already occupied by ROM routines. Therefore, this means restricting the mapping of expanded memory to the area above 640k has much the same effect as the absolute limit of 64k — there is simply not enough room to run programs.

Currently, none of Intel Corporation's Above Board EMS products, for instance, support multi-tasking, since all were designed for their own EMS 3.2.

"We're offering a 4.0 driver with our boards, but you still won't be able to get multi-tasking performance," conceded Rich Bader, general manager of Intel's PC products division. However, he noted, "the only thing not provided is concurrency. In all other areas, our boards support all of the new features of EMS 4.0."

In contrast to EMS 3.2 boards, EEMS boards can map larger quantities of expanded memory into the conventional address space at one time and can map it anywhere in conventional memory, including addresses in the lower 640k bytes. A large program loaded into expanded-memory can be mapped to conventional memory in its entirety.

According to Len Herbstman, senior marketing manager at AST Research, "The two key ingredients required in hardware in order to effectively support multi-tasking environments are the ability to have a window larger than 64k and the ability to have that window

provided the expanded-memory board incorporates the necessary hardware. In this respect, EMS 4.0 is superior to OS/2, which can only multi-task programs that are completely rewritten for the new operating system.

- A provision allowing multiple applications to share data in expanded memory.

EMS-compatible hardware

On the hardware side of the expanded-memory equation, the LIM specification itself gives only the sketchiest of hints as to how EMS-compatible hardware should be designed in order to support this extended list of features. Still, the circuitry of an add-in RAM board must meet certain minimum requirements to work as expanded memory.

"The hardware developer has to be sure that the board can divide memory into chunks, and relocate those chunks to different addresses, but how he does it is completely up to him." said Mr Pope.

Rather than enforcing a hardware standard, EMS is actually a set of guidelines for writing software that takes advantage of the additional memory provided by an expanded-memory card. The specification details the proper use of a variety of special function calls that can be employed within a program to access and manage the extra memory.

Linking the software with the expanded memory is a special device driver known as the Expanded Memory Manager (EMM). The EMM is loaded when the system boots, and performs the actual hardware interactions needed to carry out EMS function calls initiated by the application software or operatingenvironment.

The EMM driver is usually provided by the manufacturer of the add-in memory board, since the driver must match the hardware design of the board. EMM drivers are available from some third-party sources for some special hardware configurations, however.

With a complete expanded-memory system (expanded-memory board, EMS software and EMM driver) in place, expanded-memory-specification operations proceed via a technique known as page mapping, Mr Pope explained.

The design of the 8088 microprocessor used in the original IBM PC permits the chip to access only 1Mbyte of memory. And since the 80286 and 80386 processors must emulate the 8088 in order to run DOS programs, both are therefore confined within the same 1Mbyte limitation, Mr Pope said.

Operation of system components

Within IBM's microcomputers, instructions for the operation of essential system components such as the video display were assigned to memory locations with higher addresses, while only the first 640k was left available for DOS and for program operation.

To circumvent the 640k barrier, the EMS scheme commandeers an area within the 1Mbyte of 'physical' memory that is normally accessible to the microprocessor, Mr Pope continued. The memory in this 'page frame' is further divided into much smaller chunks, called pages.

RAM on the memory board is similarly divided into corresponding pages. The crucial capability of EMS hardware is its ability to make those pages appear to the microprocessor at any desired address, he said.

When a program wishes to claim expanded memory, it makes its request to the EMM driver, which selects available pages from the memory board and reserves them for the program's use. Other programs may request expanded memory until all of the avail-

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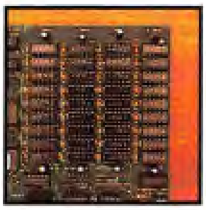

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For AST, the addition of multi-tasking support patterned on the innovations of EEMS to the LIM standard has vindicated the firm's persistence in promoting its own expanded-memory protocol.

Although more flexible memory-allocation skills are the critical elements in hardware support for multi-tasking, yet another feature of EEMS-compatible boards — hardware registers — play a role as well, and it, too, has been adopted and enhanced for EMS 4.0.

On EMS-compatible 3.2 boards, which have only a single register set, changing to a new map requires a program or operating environment to store the current map in RAM using a series of individual microprocessor instructions, and then build a new map register-by-register, Quarterdeck's Mr Pope said.

With two sets of registers, two programs running concurrently under the control of an operating environment such as DESQview can each have their own maps. Each time the operating environment switches from one program to the other, the newly active program can access its map almost instantly.

"Having two register sets turns out to make the difference between whether or not you can run 9600bps communications in the background," Mr Pope said.

"If you have to switch a program without an alternate map, it takes you as long as a communications interrupt, and you'll lose data," he continued. "With an alternate map, you can swap maps very quickly without losing communications."

Extending the advantages of the EEMS pair of register sets to even more applications, EMS 4.0 permits (but does not require) multiple hardware-register sets.

To date, the only board product that offers more than two register sets is Microsoft's Memory Plus, a piggyback add-in to the firm's Mach 20 80286-equipped accelerator board for 8088-based PCs, XTs and compatibles.

"The Memory Plus has 30 hardware register sets devoted to swapping expanded memory in and out of the 1Mbyte DOS address space," said Bridget Cameron, associate product manager for the Mach 20 at Microsoft Corporation.

"The beauty of having all the hardware-register sets is that you can dedicate each one to a particular application for multi-tasking, so you can switch from one application to another much faster," she said.

According to Ms Cameron, the Memory Plus comes standard with 512k of RAM and accepts up to 3.5Mbytes. Anticipating the future availability of higher-capacity RAM chips, the board's controller circuitry will support up to 32Mbytes of RAM, she said.

Despite the theoretical advantages of having more than two hardware-register sets, Quarterdeck's Mr Pope said that multiple sets will only be critical in special multi-tasking applications.

"The provision of multiple register sets for alternate maps may not be quite as significant as you'd think," he

able random-access memory is assigned. To access the expanded memory it has secured, the program tells the EMM to 'map' the expanded-memory pages it needs into pages in the page frame, Mr Pope said.

Once this mapping step is complete, whenever the microprocessor tries to access a memory address within a mapped page — for instance, to store the results of a spreadsheet recalculation — it will actually be accessing the corresponding expanded-memory page.

Although all versions of EMS work in this way, there are important variations between EMS 3.2, AST's EEMS, and the new EMS version 4.0, involving the location and size of the page frame.

In the EMS 3.2 specification, the page frame was limited to a 64k space located in the region of conventional memory above the DOS limit of 640k. A maximum of four 16k expanded-memory pages could be mapped into the page frame at any one time, Mr Pope said.

The EEMS specification, by contrast, allowed the page frame to be larger, occupying 256k or more. In addition, expanded-memory pages could be mapped into any address within conventional memory, including the lower 640k bytes used by DOS.

These distinctions produced an important divergence in capabilities, Mr Pope said. "As far as the user is concerned, the primary difference [between the EMS and EEMS specs] is that with EMS you could only use the expanded-memory area to store data.

"On an EEMS board, you could also store and run large programs [in expanded memory], and you could run multiple programs simultaneously under an operating environment like DESQview," he said.

Because of the growing demand for larger programs and for multi-tasking EMS 4.0 has incorporated the key features of EEMS — enlarged page-frame size and the ability to map into the lower 640k of memory — in addition to other enhancements. Although there are differences in implementation, the new EMS offers all the multi-tasking capabilities provided by EEMS, and AST Research, has announced its full support for EMS 4.0.

"There's no longer a need for EEMS as a separate standard," Tom Yuen, executive vice president for strategic planning of AST said, in a joint news release announcing EMS 4.0 from Lotus, Intel, Microsoft and AST.

Newfound unity

Much as been made of the newfound industry unity and its value to users. Rich Bader, general manager of Intel's PC-product division, said that "The biggest thing about EMS 4.0 is that there's now one standard, so those people who were confused about the different types of expanded memory in the past won't have to worry about which spec to adopt."

In addition, owners of existing expanded-memory board models can run EMS 4.0 simply by installing an upgrading EMM driver.

Most makers of EMS-compatible boards have already announced plans to include an EMS 4.0 driver with their current board products, and to supply the driver to previous purchasers of the boards.

There's a hitch in this happy picture, however, other industry officials said. Although all types of expanded-memory boards are compatible with EMS 4.0, many of them do not have the hardware design necessary for multi-tasking, a vital feature for some users.

"If you run 4.0 on a standard EMS board, you'll be able to use the 32Mbytes, you can have your multi-dimensional spreadsheet, and you can run your TSRs in expanded memory," said Len Herbstman, senior marketing manager at AST Research. "But if you're using one of the operating en-

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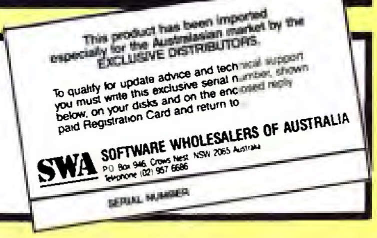

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said. "As long as there's at least one alternate map, we can dedicate that to the communications program, and [the communications link] won't be broken when you switch maps. You're only going to run into trouble if you try to run a second communications program."

Less complicated decisions

For owners of 80286-based IBM PS/2 computers, the Model 50 and Model 60, and 80386-based MS-DOS-compatible micros, EMS memory-board buying decisions are less complicated.

In its PS/2 RAM design, IBM adopted a new technology that allows any 16k portion of memory to appear at any address. This, of course, is what EMS boards do, although PS/2s use the feature mainly to move malfunctioning chunks of RAM out of the usable memory space, and fill their positions with working chunks.

The upshot is that any memory board for the PS/2 Micro Channel bus that is fully compatible with the IBM design should support EMS 4.0 without modification, according to Bill Berkman, marketing manager at Orchid Technology, maker of add-in boards and other peripherals.

Orchid Technology's RamQuest 50/60, for example, "allows the memory segments on the board to be allocated anywhere throughout the entire memory space, and hence you can emulate EEMS," Mr Berkman said.

To run EMS 4.0 software, RamQuest 50/60 owners must run a PS/2-compatible expanded-memory driver such as Quarterdeck's QEMM 50/60, Mr Berkman said.

According to Mr Pope of Quarterdeck, the QEMM 50/60 driver supports EMS 4.0 features, including multi-tasking with IBM's own Micro Channel add-in memory-option board, as well as with third-party boards that are fully compatible.

"Until recently there were no EEMS boards for the PS/2, and we had a bunch of DESQview users asking for multi-tasking, so we wrote an EEMS driver," Mr Pope said.

Fully PS/2-compatible memory boards have most, but not all, of the hardware features of the ideal EMS 4.0 board, Mr Pope continued.

"The IBM memory design supports mapping low in memory, but it does not have hardware registers for alternate memory maps. We have to emulate that feature in the driver software," he said.

Mr Berkman cautioned, however, that some Micro Channel memory boards now available do not imitate IBM's memory structure faithfully enough, and will not run expanded-memory drivers. Specifically, he claimed, the board's memory mapping facility must use a translational RAM (TRAM) design.

Because of the advanced memory-management capabilities of the 80386 microprocessor, computers based on the chip can run EMS software in ordinary RAM with an appropriate driver, according to Mr Pope. Again, Quarterdeck sells such an EMS 4.0 driver, QEMM 386.

"In virtual-8086 mode, the '386 can map memory and support an indefinite number of alternate memory maps," he

vironments that is available today, Windows or DESQview, you won't be able to do multi-tasking in expanded memory [with a conventional EMS board]," Mr Herbstman explained.

By contrast, Mr Herbstman said, existing EEMS boards and boards built to take full advantage of the new specification will provide multi-tasking capabilities.

For those users who do obtain expanded-memory boards with the hardware necessary for multi-tasking, EMS 4.0 provides further multi-tasking enhancements over EEMS, according to Quarterdeck's Mr Pope.

One of these improvements represents an expansion of a feature found in the AST EEMS spec. Conventional EMS 3.2 boards are equipped in hardware with a single set of registers for storing the map data that determines which page of expanded memory is mapped to which page in conventional memory.

Whenever a new expanded-memory page is mapped into the conventional-memory space, the contents of the corresponding register must be changed via input/output (I/O) instruction from the microprocessor.

EEMS boards have an additional register set, allowing the board to store two complete alternate memory maps, enough for two applications.

When a multi-tasking operating environment such as DESQview shifts processing control from one program to the other, the EEMS driver can switch almost instantly to the corresponding register set, rather than having to recreate the entire map, register by individual register.

This time savings translates into faster multi-tasking performance for any program that has exclusive use of one of the hardware register sets, Mr Pope said.

Under EMS 4.0, manufacturers can add multiple alternative register sets at their discretion, extending these performance benefits to many more applications during multi-tasking. Additional register sets are not required by the specification, however, and if they are not present, the operating environment will perform the remapping operations required during multi-tasking.

In addition, Mr Pope said, EMS 4.0 allows expanded-memory pages to conduct background direct-memory access (DMA) data transfers, such as those that occur when reading from, or writing to, a disk, while other portions of expanded memory interact with the CPU. Again, this feature requires special hardware registers, but these are not mandated by the new EMS standard.

Even with hardware that fully supports all the features of EMS 4.0, any software that hopes to take advantage of the new capabilities has to be rewritten using additional function calls of the specification. Software written for EMS 3.2 will still run under an EMS 4.0 driver, but it will not benefit from the enhancements.

To date, only a few application software vendors have committed themselves to supporting EMS 4.0. Prominent among these, of course, is Lotus. According to a Lotus spokes-person, the firm has promised that 1-2-3 release 3, running under EMS 4.0, will be functionally equivalent to the version running under OS/2.

For their part, multi-tasking operating-system vendors have been quick to announce support for EMS 4.0.

According to Quarterdeck President Therese Myers, a version of DESQview that incorporates EMS 4.0 support, release 2.01, is already complete.

"There isn't much we can test it with so far, but it runs on everything we've tried, including the Microsoft Mach 20 [a new accelerator board that includes EMS 4.0-compatible memory]," Ms Myers said. The new version of DESQview maintains support for earlier versions of EMS and EEMS, and configures itself automatically for the type of expanded

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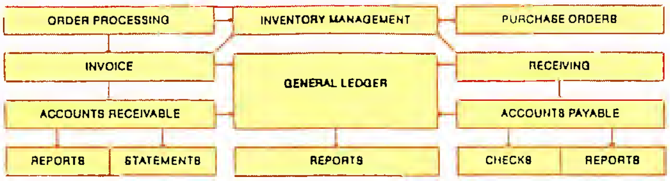

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said. "It's an analog of EMS, so you can use a straight RAM board."

Aside from the thorny issues surrounding multi-tasking, the important features that should be evaluated when choosing an EMS 4.0-compatible board are fairly straight-forward, industry observers say.

Keep it simple

One simple issue is the board's capacity. Now that the limit on EMS memory is 32Mbytes, rather than 8Mbytes, and with indications that OS/2's capacious memory may soon be stretching wide, users may have good reason to baulk at EMS boards with a 'mere' 2Mbyte to 4Mbyte maximum capacity.

Among the current crop of expanded-memory boards, Profit Systems' Elite 16 is unique in offering up to 16Mbytes of RAM on a single card. According to the firm's Mr Bentzel, this high-memory density is achieved using special single in-line memory modules (SIMMs) instead of conventional RAM chips.

A recently announced EMS 4.0-compatible board, the Rapid MEG AT, from STB Systems, approaches the Elite 16's capacity, holding a maximum of 10Mbytes using a daughterboard option, said Brian Dean, STB's memory-products marketing manager.

The user who lacks a full 640k-complement of conventional RAM may find it convenient to fill that deficit by reassigning a small portion of the board's expanded memory. And since both Xenix and OS/2 require extended, rather than expanded memory on 80286 and 80386-based systems, users who plan to run either operating system in addition to EMS 4.0 software will want to be able to convert between the two memory types, he said.

Several boards allow such memory reconfiguration, including the AST Advantage Premium the forthcoming STB RapidMEG AT and the Profit Systems Elite 16.

According to Mr Bentzel, for example "The Elite 16 is a physical platform for a multi-mode environment — you can mix and match to get any combination of memory you need."

The Elite 16's expanded-memory driver simplifies memory-configuration chores each time the user boots the computer, he said.

"The driver wakes up the board automatically, backfills conventional memory to 640k, and throws what's left over into expanded memory. Then it turns control back over to you so you can allocate memory between expanded and extended memory with a few keystrokes," he said.

Microsoft's Mach 20 is primarily intended to permit older 8088-based micros to run OS/2, the firm's Ms Cameron said.

The Memory Plus daughterboard supplies EMS 4.0-compatible expanded memory when used with DOS, but will automatically reconfigure itself as extended memory when the system is booted with OS/2.

Some boards automate all aspects of memory running on the user's system, she said.

Microsoft's Windows operating environment will also support EMS 4.0 in two new implementations, Windows 2.0 and Windows 386, according to Adrian King, manager of operating-system products at Microsoft. "[The new LIM specification] makes it feasible to run more Windows applications, because we can use the extra memory in a much more sophisticated way than we could with the old spec," he said.

"At the moment, the Windows kernel just uses expanded memory like a RAM disk when it swaps applications in and out. The memory management in Windows 2.0 is much more sophisticated, and you will see a big boost in performance when you're multi-tasking," he said. Mr King confirmed, however, that the multi-tasking enhancements will only be available with expanded-memory boards that provide full hardware support for the new EMS features.

Since the Windows 2.0 user interface will be the same as that of OS/2's Presentation Manager, the two environments will be functionally identical for some users, although OS/2 will offer advanced features that other users may require, Mr King said.

Mr Pope said that he believes many software companies will eventually support the new EMS standard, especially as more boards with full hardware support for the spec appear. "The big battle between EMS and EEMS did a disservice [to users], because many developers were probably confused and didn't commit to anything. I think we'll see a lot of people who had been hesitating [now] coming out with EMS software," he added.

If that software is indeed forthcoming, EMS 4.0 may well prolong the useful life of the significant investments in DOS software that many users have made.

END

Common terms used to define EMS boards

Expanded-memory boards: Expanded-memory boards will provide the user with more than 640k of memory. These boards meet the Lotus/Intel/Microsoft Extended-Memory Specification (LIM) standard

Extended-memory boards: All boards with memory over 640k are considered as providing extended memory.

Enhanced expanded-memory spec boards: Enhanced expanded-memory boards allow users to run programs above 640k of memory.

Capacity: This refers to the total memory at maximum capacity.

Speed: Also referred to as clock speed, this is defined as the speed of the microprocessors in which this card can run.

New 4.0 Lotus/Intel/Microsoft spec: This is the new specification standard for memory boards that was developed by a collaboration of four add-in board makers: Lotus, Intel, Microsoft and their heretofore rival AST Research. With the new spec (4.0), 32Mbytes of memory are available, programs can be written so they execute within expanded memory and there is support for multitasking of multiple DOS programs.

Wait states: Wait states are the time a program cannot use the central processing unit while the unit is waiting to complete an input/output (I/O) operation.

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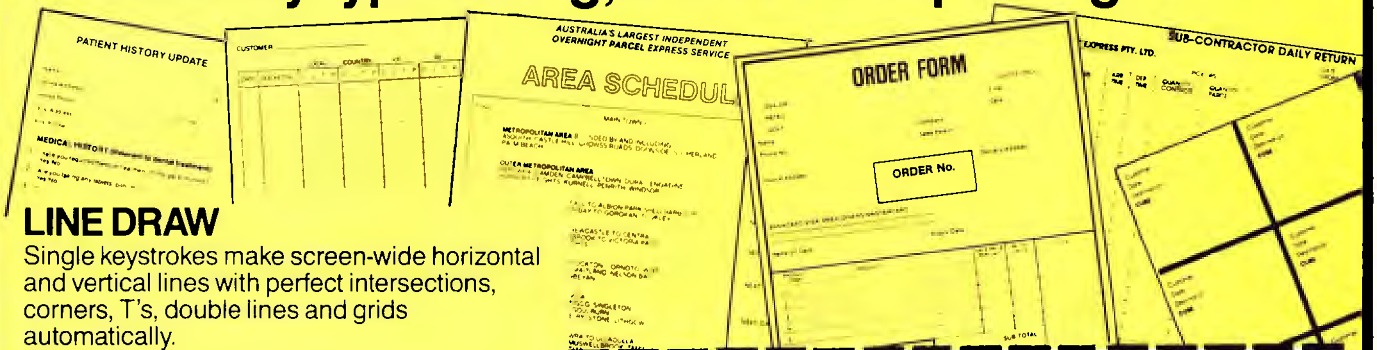

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board installation and setup, pointed out Intel's Mr Bader. "Installation is definitely something to take a look at when you're choosing an EMS board. Some of the boards are totally switchless, where others still have dip switches and can take a lot more time to install," Mr Bader said.

The company's Above Board products configure themselves automatically for the system in which they are installed, and the user need not set any switches manually, he said.

Profit Systems' Elite 16 boasts similarly automated installation, according to Mr Bentzel. "The driver automatically sets the parallel and serial ports depending on the ones that are already in the machine. It also tests the memory, and if it finds a bad location on a SIMM it doesn't throw out the entire chip, it just locks out that location and closes the gap. The only thing you have to do manually is turn one knob if the board you're installing is the second one in the system."

Speed is yet another feature that may influence the selection of an expanded-memory board. While most EMS boards are designed to run at 8MHz, with one wait state, some are specifically engineered to support higher speeds. STB's RapidMEG AT, for example, will run at 12MHz, with one wait state, which is equivalent to over 9MHz with zero wait states, Mr Dean said.

"There's very much a place out there for boards running at the higher speeds, especially when you're talking about multi-tasking environments," he said.

"These days, the vast majority of AT-compatibles being sold are at least 10MHz, one wait-state machines, but some of the board companies still haven't addressed the need to run at the higher speeds."

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Attractive features

Rounding out the list of features to consider when shopping for an EMS board, additional I/O ports can be a considerable advantage for many multi-tasking applications. Like the multi-function boards so common in previous years, many of today's EMS boards offer one or more serial, parallel or mouse ports as standard or optional equipment.

With so many issues to factor in when choosing an EMS 4.0-compatible memory board, the widely heard claims of industry unity on the new standard may sound exaggerated to some. Clearly, careful shopping is a must, particularly if the new EMS's multi-tasking benefits are critical.

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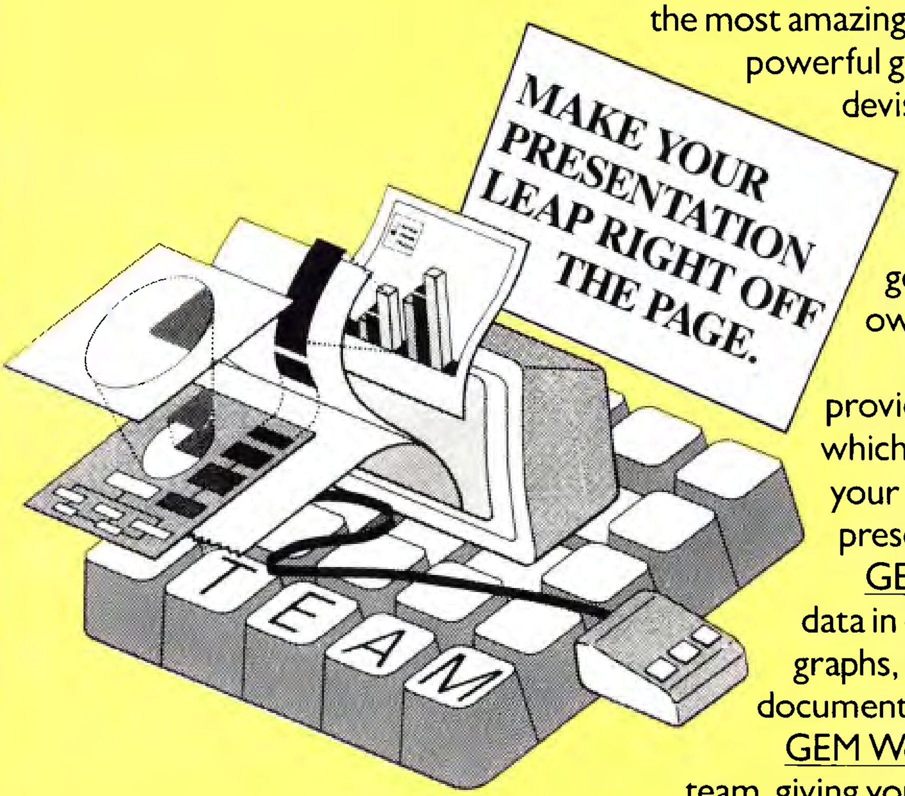
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A tale of two VGAs

The compatibles manufacturers are scrambling to meet the challenge of IBM's new PS/2 hardware, and an integral part of that challenge is IBM's new display adaptor standard. Ian Davies takes a look at two of the latest offerings.

IBM seems destined to be surrounded by a plethora of display standards to confuse its customers and frustrate developers. When IBM released its original PC range, it provided two completely incompatible display systems: MDA and CGA.

Neither of these were entirely satisfactory. The MDA could only perform monochrome text display, but did so extremely well, with good character definition and high speed screen updates. The CGA could perform text, colour and graphics; but the colours were extremely limited, resolution was poor, screen up-date speed was slow and the text definition was untenable.

The CGA was the greatest loser of all times. Indeed, its combination of features could not even provide full support of the decade old Prestel presentation standard. Characters were drawn in an 8-dot by 8-dot font and appeared, to say the least, dotty. It was virtually impossible to use the CGA for any extended text work. Moreover, short cuts taken in the CGA design meant that the screen would continuously 'flash' when many software products updated the screen.

So initial IBM buyers had to choose between monochrome text with absolutely no graphics ability, or colour and graphics to a certain extent but with terrible ergonomics. Most users wanted text primarily, but with the occasional graphic. For these users, the best option was to buy both display adaptors and both monitors.

Then a company called Hercules created a monochrome display adaptor, which was supposed to be compatible with everything but actually not really compatible with anything. And so the HMDA standard was born. IBM countered with the PGA, a very expensive board designed for high-resolution applications which very few people actually purchased. It was, of course, incompatible with the other three standards.

Finally, IBM released the EGA, a much better display adaptor with good graphics, a useful range of colours, readable text mode and a penchant for very expensive monitors. The clone makers developed EGA-compatible chip sets which were able to make the EGA more compatible with previous adaptors, and the industry leaped at them. It reached the point where the IBM EGA was the odd man out in terms of features and compatibility, and could almost be considered to be incompatible with the industry de facto EGA standard.

The sixth standard

Anyway, with the new PS/2 range, IBM has released its fifth display adaptor board — the sixth standard. The VGA is essentially, an EGA done properly, with additional modes to generate a stunning range of graphics. Because the VGA supports a palette of 262,144 colours, IBM was obliged to move towards analogue display adaptors in place of the normal digital adaptors the latter being capable of only 16 display states. These analogue adaptors are, needless to say, *expensive*.

The most important single feature of the VGA is that it has been built into the system board of all major PS/2 models. This means that users are no longer faced with difficult display decisions, and that developers can be reasonably confident of the hardware they are working with. Additionally, the implication is that colour is officially here. Of course, the five other standards are still alive and well out in the marketplace, but they will eventually die the long and lingering death of the unsupported.

Every indication is that VGA is *the way to go*.

Many EGA compatible vendors found it relatively easy to emulate the VGA by essentially using their existing hardware. And now vendors have achieved VGA emulation while still supporting the EGA standard (as IBM does), and are also downwards com-

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patible with the CGA, MDA and HMDA to a greater extent than IBM.

Hardware

The VEGA VGA and Quadram Ultra VGA appear to be very similar boards, yet are quite different in their functionality and packaging Both devices are standard 'short' boards capable of being plugged into any 8-bit slot in your machine. Both consist of two large VLSI chips and a ROM. The Quadram contains 19 other discrete component chips, and the VEGA contains 17 others, most of which are surface mounted and one of which is an Inmos DAC (Digital to Analog Converter) similar to the one used on the IBM PS/2 planar board. The Quadram board includes six option switches on the back plane, digital monitor plug and two RCA type composite video sockets. The VEGA also has six option switches, and two 9-pin 'D' type video connectors, one for analogue monitors and the other for digital.

The astute reader would just have asked, but how can the Quadram UltraVGA be a VGA adaptor if it can't run an analogue monitor?

Good point. In order to support a palette of 262,144 colours, an analogue monitor must be used. The VGA does this, as does the VEGA, but the Quadram Ultra VGA does not.

Indeed, the two boards try to be different things. The VEGA includes a lovely piece of paper which says that Video Seven, the manufacturer, guarantees that its board will be compatible with software written for IBM VGA, MDA, EGA, CGA and Hercules HMDA modes. It further guarantees that *any* software which will run on an IBM PC with one of the IBM cards will also run correctly if the IBM card is replaced with the VEGA card. If it doesn't, Video Seven will fix it or refund your money. Pretty impressive.

Quadram, on the other hand, includes a warranty which promises that the Ultra VGA will operate as documented in the manual for two years following the purchase date. The manual very carefully states that the Ultra VGA ". . . provides graphics capabilities far beyond those of current EGA boards, but still retains full downward compatibility with the MDA, CGA, EGA and Hercules standards." No mention of VGA, except in the name of the product. It goes on to detail all of the emulation modes supported, and again does not mention VGA.

The IBM VGA offers three new display modes beyond the standard EGA, these being modes 11, 12 and 13 (hexadecimal). The modes provide resolutions of 640 by 480 in two or 16 colours, and 320 by 200 in 256 colours. The VEGA VGA supports all of these modes, whereas the Quadram Ultra VGA does not support mode 13 (256 colours), nor standard mode 7, a text mode with a 9 by 16 character resolution.

In fairness to Quadram, you could run 100 different software products which support the VGA and not find a single one which utilises mode 13. In fairness to the customer, you could also find that the package *you* want to run is one of the minority which does use mode 13.

Added extras

The pricing is interesting, as the Quadram costs $21 more for an inferior emulation. However, a free mouse is included. TheQ-Mouse is an optical device, which means that it must be operated on a small reflective pad 23 by 20 centimetres. A sensor on the bottom of the mouse latches onto the reflective spots and figures out its movement vector from the patterns of dots moving underneath it.

Optical mice used to be fairly common, as they have the advantage of never clogging up. Mechanical mice of advanced years often lose their accuracy and repeatability through dirt and wear and tear on the bearings. Optical mice have no moving parts and therefore have virtually nothing to go wrong. The only disadvantage is that they must be used on the reflective pad.

The Q-Mouse provides two buttons, and a serial interface. The serial interface is an indication that Quadram is back in the old days of the IBM PC range and is not really up to date with the PS/2 range. IBM originally used 25-pin 'D' type serial ports, then moved to 9-pin ports on the AT, then back to 25-pin for the PS/2 (cable makers have to make a living, you know).

The Q-mouse has a 9-pin cable, which means it will plug straight into an AT, but will need an adaptor cable for either the PC, XT or PS/2 machines. It is completely independent of the display adaptor, and one is left with the impression that Quadram bundled it in order to maintain competitiveness.

Both adaptors provide a light pen adaptor, a feature IBM has always included on its graphics adaptors but removed from the VGA. This is a potentially useful feature, and essential in order to maintain complete CGA and EGA compatibility.

Software

Similarly, both products include utility software disks. The VEGA disk includes an install program which controls options such as screen saver, RAM BIOS installation and other driver installation. The RAM BIOS option allows the VGA BIOS to be copied from the on-board ROM into main system RAM. This can deliver a performance boost since the board plugs into an 8-bit slot whereas your computer may have full 16-bit or even 32-bit memory. Interestingly, the Compaq 386 machine performs the

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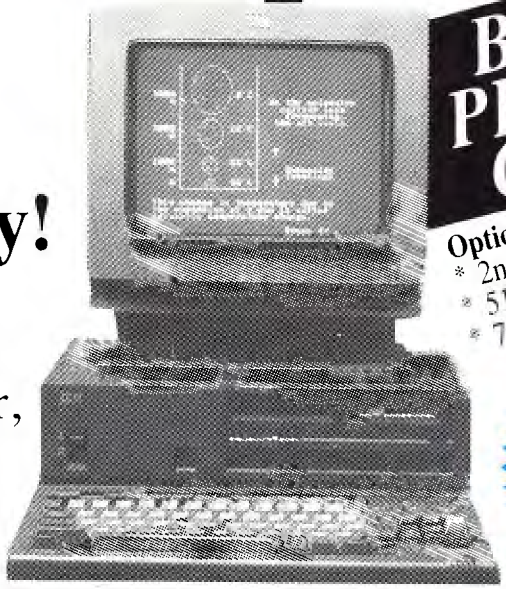

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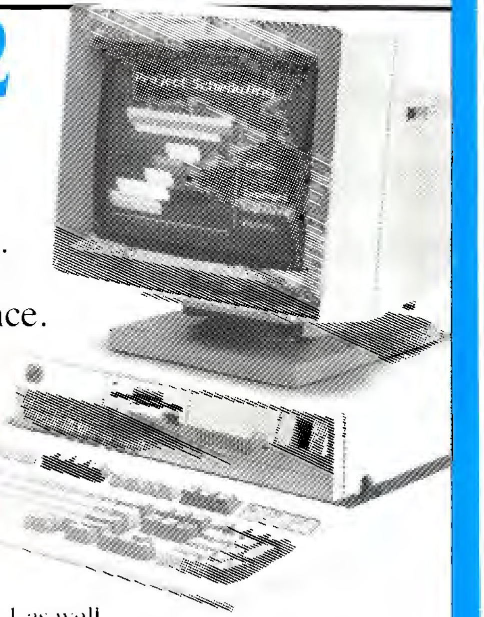

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same trick during bootstrap, so do not select this option if you are using the Compaq 386.

Another utility allows software selection of modes which can be configured through the DIP switches. It allows the card to be forced into CGA or HMDA emulation, or to be left in autoswitch mode. Drivers are included for Microsoft Windows, AutoCAD and Lotus 1-2-3. A replacement ANSI.SYS is also included along with diagnostics and directory utilities.

The Quadram disks also include a mode selection utility and a small program which allows the adaptor to be kept in one of its emulation modes even though the system may be rebooted. This can be useful with games which require the system to be booted from a floppy. Drivers are provided for AutoCAD, GEM, Microsoft Windows, Lotus 1-2-3 version 2.0 (or greater), Framework II, Ventura, WordStar Professional and WordPerfect.

The VEGA can work with a variety of display adaptors, including monochrome, low-resolution colour, high-resolution colour, variable frequency and analogue. Not all display modes are available, depending on the monitor type, for example, 256 colour mode requires an analogue screen. The Quadram can also support a similar variety, with the exception of analogue.

Conclusion

Really, the only problem between these two boards is that Quadram chose to call its board the Ultra VGA, because it's not a full VGA. It is more accurately an extended EGA whose extensions correspond to some, but not all, of the IBM VGA standard modes.

The VEGA VGA on the other hand, is a full VGA emulation complete with analogue monitor support and 256 colours.

As far as buying is concerned, the Quadram costs $975 and the VEGA $954. From that point, it depends on how good an emulation you require, and whether you could use another mouse. I'd have to go for the VEGA, simply because I'd want to buy a full VGA and not an extended EGA. Additionally, the VEGA guarantee creates great confidence in future compatibility.

END

The Quadram Ultra VGA is available from Sourceware on (02) 411 5711, and the Video Seven VEGA VGA is available from Dimension Graphics on (02) 929 5855.

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Modelling the brain

A neural-network approach to natural-language processing and similar problems may be the key to building systems that 'learn'. Matthew Zeidenberg explains.

The idea of simulating the brain formed the foundation for much of the early work in artificial intelligence. The brain was seen as a 'neural network', that is, a set of nodes, or neurons, connected by communication lines. Lately, there has been a substantial revival in the use of neural-network models, or connectionism, as the field is often called (see reference 1). Connectionist models are applicable to a variety of cognitive-science problems, including natural-language processing, speed processing, and vision.

One major advocate of connectionism is Daniel W Hillis. His Connection Machine is more brain-like than a traditional computer. Hillis points out than in a conventional computer, most of the silicon lies inactive most of the time. At any given time, only the CPU and a very small part — a few bytes — of the memory are active (see reference 2). The Connection Machine is composed of many processor/memory units, most of which are active at the same time. Douglas R Hofstadter (see references 3 and 4) has long been an advocate of a similar view of cognition, with interacting actors in a cognitive process exchanging messages.

On the simplest level, the brain functions are as follows: neurons activate or inhibit the firing of other neurons. Whether or not a particular neuron fires depends on the inhibitory or excitatory inputs from all the neurons connected to it. Somehow, the activations of all the neurons, how they communicate with one another, and the nervous system's interactions with the environment determine your memories and thoughts — at least as far as philosophical materialists are concerned.

Of course, neurophysiologists, while still largely in the dark as to the operation of higher cognitive functions, have learned a great deal more about the brain than is evident in this simple model. Nevertheless, scientists in the 1950s were amazed at what simple systems of nodes with excitatory and inhibitory connections could do. (See the accompanying box 'The perceptron controversy'.)

In 1943, Warren S McCulloch and Walter Pitts proved that any neural-network model in which a finite amount of information could define the state of an individual neuron could be modelled on a standard computer. The 'finite amount of information' assumption is a big one: the number of bits needed to describe the state of a given neuron may be so large that it makes the simulation slow and impractical.

Is the brain relevant?

A strong school in AI feels that studying the brain is not the most fruitful road to understanding thought. The brain represents just one way of making a thinking machine, and certainly not the optimal way. Traditional AI sees thought as a series of problems to solve, and believes strongly that there is no philosophical reason why a computer can't solve them. The basis for this belief is the Church-Turing thesis, which roughly states that if a function is computable, you can compute it with a conventional computer — formally, a Turing machine. This thesis cannot be proved, but it is widely accepted because no one can think of a counter-example.

Daniel Dennett of Tufts University, USA, argues that neurophysiologists, working from the 'bottom up' — that is, from the minute details up to the overall problem to be solved — in an attempt to understand human cognition, and computer scientists, working from the 'top down', may ultimately both reach their goal. But he thinks the computer scientists will reach it first (see reference 5). The argument is: if I take a computer running a spreadsheet, and try to figure out what the program is doing by looking at the electrical currents inside, I won't progress as quickly as I would if I tried to write another program that also runs a spreadsheet.

In an approach that is in between those of the neurophysiologists and the more traditional AI researchers, David

E Rumelhart, James L McClelland, and their colleagues don't dismiss the brain as irrelevant to the functioning of the mind. Rather, they feel that, by experimenting with neural networks, they can gain insight into how the brain copes with the problems it has to solve.

Parallelism

Another reason for studying brain-like models is their parallelism. The 'circuitry' of the brain is much slower than a computer's. In order for the brain to work as fast as it does — psychologists have shown that we can recognise objects in a split second — many neurons must work in parallel. In contrast, many AI programs run very slowly. The hope is: if we can find ways to run AI programs in parallel, they will run in a reasonable amount of time.

Parallel computation has been a busy area in computer science over the past 10 years. Most mainstream research on parallel computing is quite different from the neural-network approach. Researchers have studied algorithms for mesh-connected arrays of processors, pipelines, processors arranged in a tree-like fashion, and distributed systems of interconnected processors, to cite just a few.

Neural networks represent only one line of research in parallel computation. Basically, you must answer two fundamental questions in designing a parallel computer system: how do you connect the processors for communication purposes? And how much computing power and memory do you put in each processor? Many researchers find no reason to restrict themselves to neural-network models, which represent a very small subset of the possible parallel-computing models.

Nevertheless, neural-networks researchers think that their models, by being most faithful to what we know about the brain, will show the most success. Unfortunately, neural networks have seldom been built in hardware; normally, they must be simulated in software. These simulations have typically been very slow, since one processor had to do the work of many. Until we build effective parallel-processing hardware, connectionist models are unlikely to provide computationally efficient solutions to AI problems.

> *'Until we build effective parallel-processing hardware, connectionist models are unlikely to provide computationally efficient solutions to AI problems.'*

The connection machine

One attempt to build a parallel computer is Hillis's Connection Machine, which has many small processors, each containing a small amount of memory. The machine has a fixed architecture — that is, certain processors are physically connected to certain others. Any pair of processors not physically connected can communicate in software via special processors called 'routers', which exist to forward messages. It is critical that connections between processors be programmable so that the machine is not limited in the types of networks it can realise.

Hillis's machine can realise a wide variety of network models. It can adapt itself to the mesh-like architecture used in image processing, as well as to conventional semantic networks for knowledge representation. Recently, the Connection Machine has shown that it is well suited to database tasks, which are closely related to semantic networks. Hillis's company, Thinking Machines Corporation, has built a prototype of the machine, which it is marketing. The company provides a version of the popular AI programming language, LISP, that allows you access to the power of parallelism without having to know the details of the machine. On the Connection Machine, you can implement a neural network in hardware rather than in software, so the network will run much faster.

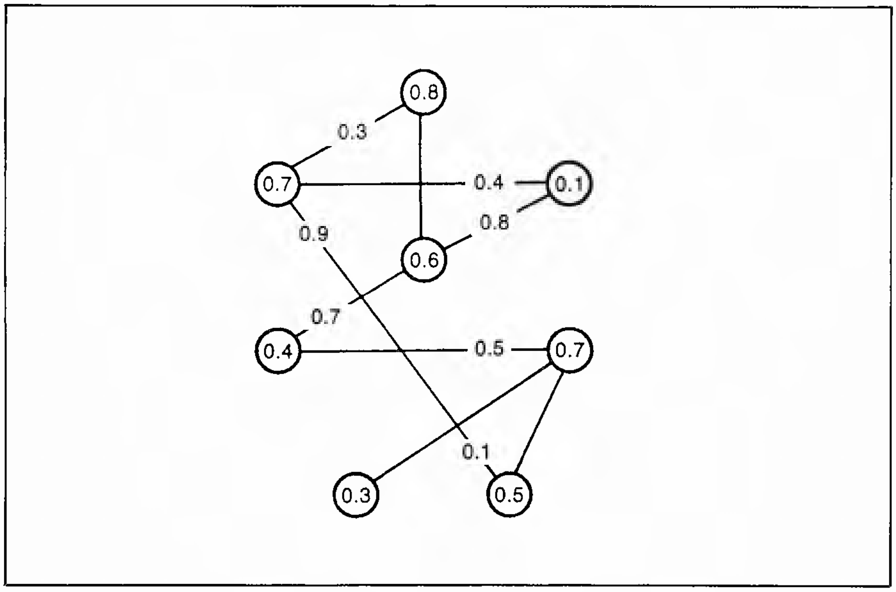

Fig 1 In a typical neural network, every node has an activation, and every connection between nodes has a weight. A rule, which varies from network to network, governs the way in which weights and activations change over time

Varieties of neural networks

Most neural-network models owe something to perceptrons but are more general. The typical neural-network model consists of a set of nodes, or neurons, and connections (see Fig 1). Each node contains a real number, which is its activation. Each connection also contains a real number, its weight. These numbers are usually positive and usually have a maximum value. Some of the units are connected to input and output. The weights represent the strength of the connection between two neurons.

Generally, a neural network is a dynamic system, moving from one state to the next. As such, it has a mathematical rule that takes the system from one state to the next. An infinite number of such rules is possible. However, we usually want to constrain our models to those that influence the activation of a given node based only on the activations of the nodes connected to it and the weights of the connections to those nodes.

Neural networks are not explicitly programmed like a conventional computer. Rather, they obey laws, or rules, like a physical system. You must

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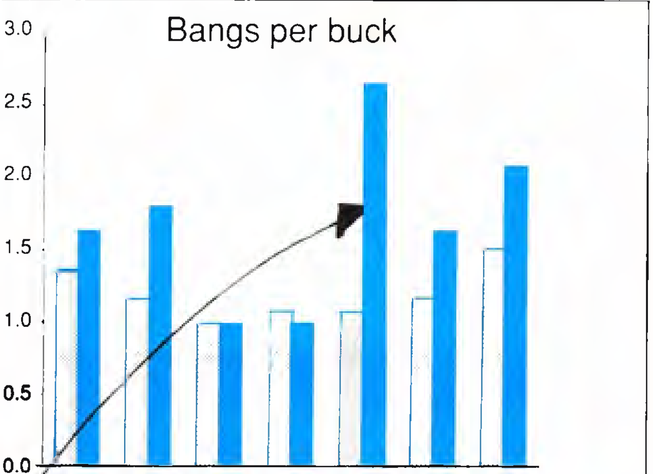

'Bangs per buck' — just one way of comparing the relative merits of these seven ultra-cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines in order from left to right are from Altantis, Rod Irving, MicroDOS, Commodore, Uni-x, Atronics and Technology Interface)

Processor.

NEC. The Uni-x contains a NEC V20, manufactured by Sony.

Thus a V20 running at 4.77MHz will outrun an 8088 running at the same clock speed.

machines examined provided a standard PC clock rate of 4.77MHz as a minimum, although the Uni-x delivered higher than standard performance even on this clock rate by virtue of the V20. The Atlantis and machines

Performance.

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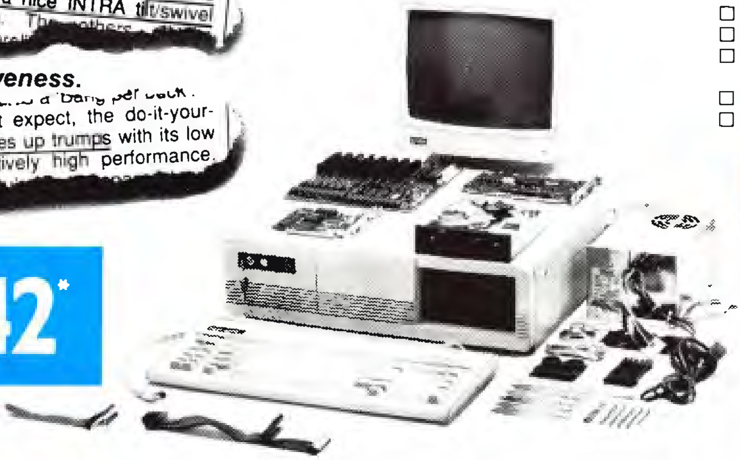

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PRICE SUBJECT TO EXCHANGE RATE VARIATION program a conventional computer, but a neural network simply behaves. Neural-network designers view this as an advantage, since it provides a mechanism whereby intelligence can arise from physical law.

One of the simplest of these rules is a linear rule. You compute the activation of a given node as the sum of the products of the weight of each node it is connected to and the strength of that connection. Often such a rule is thresholded: values that go above a certain threshold are cut off, to avoid arbitrarily large activation values. There are many variants of linear rules.

Another rule, suggested by D O Hebb (see reference 6) strengthens the connection between two nodes that are highly activated at the same time. Some versions of the Hebbian learning rule allow inputs, called teaching inputs, to influence the change in weight. This type of rule is a formalisation of associationist psychology, which holds that associations are built up between things that occur together.

Competitive learning

Learning is, perhaps, the most important phenomenon in psychology. Early neural-network researchers were anxious to show how networks could learn patterns in the input presented to them — that is, how they could come to perceive these patterns on their own.

One of the methods that various researchers have devised over the years is competitive learning. This method has a bottom level of input units that contains the pattern to be input to the system. The level above the input units consists of clusters of units. Each unit in a cluster competes with the other units in the cluster for the right to recognise an input pattern. Over a learning period, each unit in a cluster comes to recognise a subset of the patterns presented to it. Thus, each cluster represents a classification, or group, of input patterns.

In competitive learning, each unit in each cluster is connected to all the input units. The weights of the connections are initially set to random values. The random weights cause certain units in clusters to start responding more to particular input patterns, since the weights of the connections to particular input units are stronger to some than to others.

As the learning proceeds, the weights change. As particular units in the cluster become sensitive to particular units in the input pattern, the weights connecting the associated pairs of units increase, at the expense of unassociated pairs of units. Different units in the same cluster inhibit each other, so that only one unit in a cluster 'wins' the right to recognise a given pattern.

Thus, over time, different units in a cluster come to 'recognise' different properties of input patterns. For instance, a cluster of two units might

The perception controversy

The 1950s brought substantial interest in what neural networks could do. After all, if we understood their behaviour, we would be able to understand the brain and the mind. That was the hope. One of the most popular variants of the neural network was the 'perceptron', invented by Frank Rosenblatt. The perceptron was a 'perception machine'.

Perception has always been the most difficult area in AI, and the area in which the least progress has been made. The ability to decipher the world, to break it up into meaningful parts, is a human ability of astonishing complexity.

Ironically, areas that people view as difficult — like playing chess or solving a chemical structure — are areas in which AI programs have had the most success, although they seldom equal the abilities of the best human experts.

Yet, the computer has not been programmed that can learn a language the way any infant does, or given a scene of any room, can recognise all the objects in the room. Thus, machines that can perceive have always held special interest.

What is a perceptron?

A perceptron is a neural-network model with an array of input units, each of which can take on the value 0 or 1. This array is called the retina, in analogy to human vision.

The perceptron also has another array of units called the predicates. Each predicate can be connected to any subset of the units in the retina and can compute any linear function of the values of these units.

Finally, the predicate units are connected to one or more decision units, which return a single answer — yes or no — depending on the values of the units in the retina. Thus, a perceptron can perform an elementary classification task — that is, it can classify input patterns by some property. Since perception is basically a classification problem (ie, classifying objects as chairs, tables, or whatever), the hope was that the perceptron model, properly elaborated, could account for complex perception.

The great debate

The controversy over perceptrons continued for some time, and in 1969, Marvin Minsky and Seymour Papert wrote a formal analysis of perceptrons (see reference 7), or, more precisely, the single-layer perceptron, which squelched interest in them.

Minsky and Papert proved, mathematically, that there were certain functions of input that the single-layer perceptron could not compute. One of the simplest was the parity function, which tells if the number of ones in the input is even or odd. If the perceptron could not compute such a simple function, they reasoned, it could hardly perform the complex tasks required for perception and intelligence.

At the same time, Minsky and Papert's work appeared to have destroyed perceptrons and perceptron-like models as viable lines of AI research. Little attention was paid to the fact that they directed their criticism at a very simple system, the single-layer perceptron.

If you add one more layer of units between the input units and the predicates, the computational power of the machine rises abruptly, and Minsky and Papert's critique no longer applies. And if you add multiple layers, it is difficult to characterise formally the network's behaviour.

This difference was not well understood at the time, and Minsky and Papert's work put a strong damper on research. It didn't discourage everyone, however: throughout this time, Steven Grossberg of Boston University continued detailed studies of brain-like systems.

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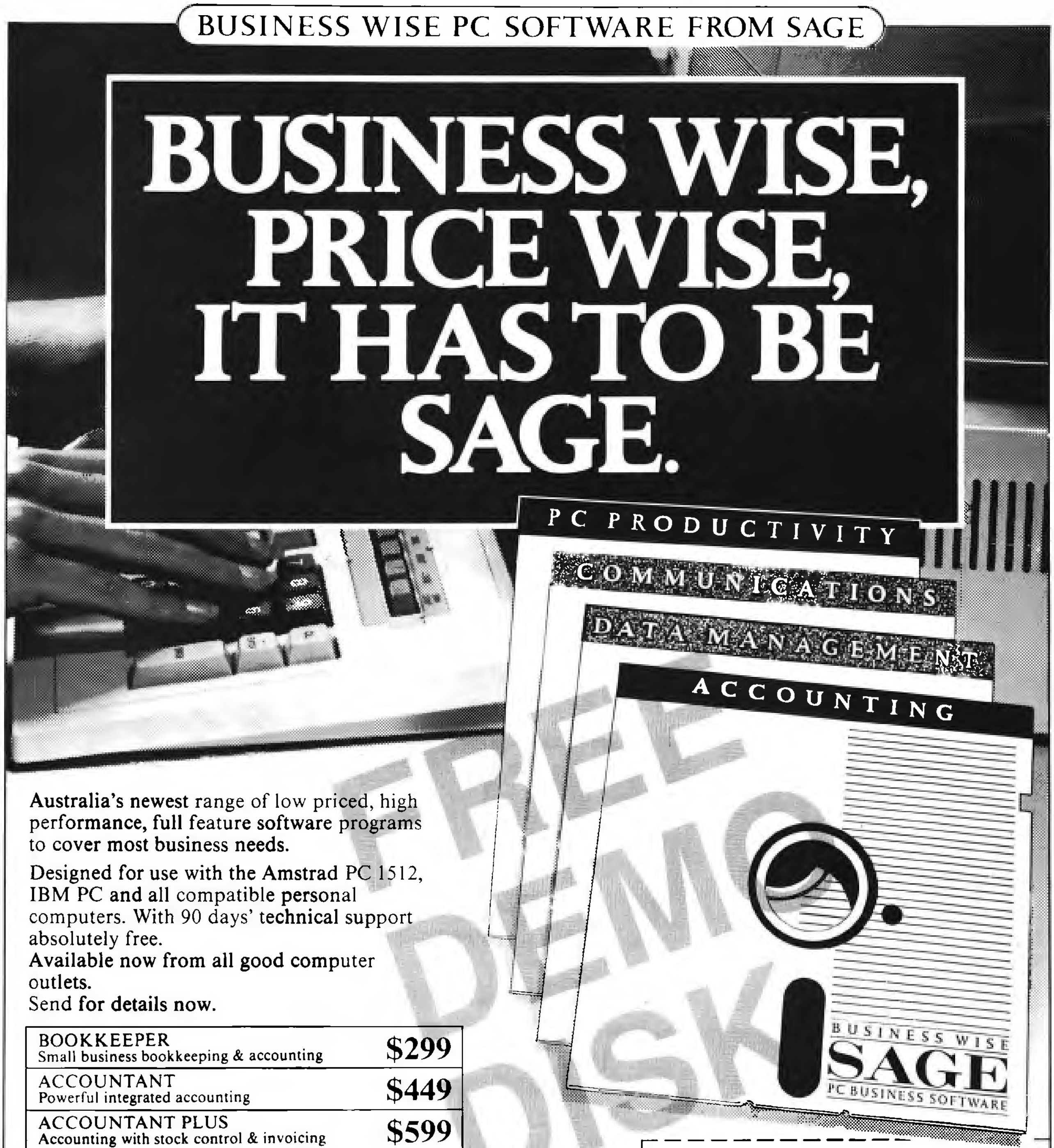

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separate all the input patterns into those that are mostly on (ie, have most of their units highly activated) and those that are mostly off. Larger clusters would make more discriminating classifications.

There may be an additional level of clusters that uses the first level of clusters as its input pattern. This level could extract more complex features from the bottom-level input pattern.

Rumelhart and David Zipser applied the competitive-learning paradigm to letter and word recognition. Letters were represented by bits on a grid, which was the input pattern for the competitive-learning system. The system came to spontaneously recognise an 'A' and a 'B' in a fixed position on the grid.

This is very interesting, for it illustrates a potential mechanism by which people may have learned to recognise letters. This mechanism is completely general, since it presupposes nothing about the letters except that they can be distinguished from one another.

Boltzmann machines

An important class of neural networks simulates the behaviour of physical systems. Physical systems have a tendency to move into states of minimum potential energy. A simple example of this is a ball rolling into the valley between two hills. At the top of the hill, potential energy is high; in the valley, it is low.

This process is called relaxation. John Hopfield has shown that a certain simple evolutionary rule for a neural network will lead to relaxation. Systems such as Hopfield's, which resemble thermo-dynamic systems like the atoms in a room, are called Boltzmann Machines, after Ludwig Boltzmann, a physicist who made major contributions to thermodynamics. Boltzmann Machines are widely used in a variety of neural-network applications.

In vision and in playing games, you can often formulate solutions to problems, such as recognising a set of objects or discovering the best move, as constraint-satisfaction problems. For instance, in chess, the constraints are the possible ways that a piece can move, and the total 'goodness' of the move, as measured by some formula, taking into account pieces captured, board position, and so on. Relaxation can correspond closely to constraint-satisfaction — a Boltzmann Machine can satisfy constraints automatically.

Distributed representations

One important feature of many neural-network models is their distributed nature. A standard semantic network, like those used in early knowledge-representation schemes, consists of a set of nodes connected in some fashion. Each node represents a single word or concept. If the network is 'thinking' of the word 'cat', the node for 'cat' is activated, and all other nodes are not. This is a local representation.

In contrast, in a distributed network, nodes don't have a simple meaning; rather, an individual concept is represented by a pattern over all the nodes. For instance, if there are 10 nodes, activating nodes 1, 3, 4 and 7 might represent the concept 'gorilla', while activating nodes 2, 4, 5 and 7 might represent the closely related concept 'chimp'. Concepts that are closely related have similar representations.

> *'In a distributed network, nodes don't have a simple meaning; rather, an individual concept is represented by a pattern over all the nodes.'*

A parallel distributed-processing (PDP) network, a neural network that uses distributed representation, offers the advantage of automatic generalisation. If I want to represent the concept 'gorillas are hairy', I strengthen the connection between all the nodes composing the concept 'gorilla' and all the nodes composing the concept 'hairy'. As a result, since most of the nodes in 'gorilla' are also used in 'chimp', an association is also made between 'chimp' and 'hairy'. This is how automatic generalisation works. In a local representation, where 'gorilla' and 'chimp' are represented by separate nodes, a connection between 'gorilla' and 'hairy' would not imply a connection between 'chimp' and 'hairy'.

Another advantage of a distributed representation is its insensitivity to damage. In a local representation, if the system loses the node representing 'grandmother', it loses its concept of grandmother. People don't display disorders like this; there are no people who are completely normal except that they have lost their concept of grandmother. This has led to the opinion that the brain doesn't use local representation.

In a distributed representation, in order to lose a concept, you must lose all the nodes representing it. If you lose only one or two of the nodes, the concept may be degraded, but it's still there. This is closer to the type of memory loss seen in older adults: memory is degraded in a uniform fashion.

Schemata

One criticism of neural-network models is that they're not as flexible at representing knowledge as standard methods are. The standard methods include the local semantic network, of which Marvin Minsky's *frame* and Roger Schank's *script* are varieties. For instance, a frame description of a bedroom would contain information about all the objects in that room and how they relate to one another. The relations between objects are represented by labelled links.

Cognitive psychologists, notably developmental psychologists like Jean Piaget, use the concept of a schema. A schema is a mirror — in the mind — of a real situation. As children, and as adults, we learn new associations and relations between objects and integrate them into our schemata.

It's not immediately clear how a neural-network model can account for knowledge represented in a schema; however, Rumelhart, Paul Smolensky, McClelland, and Geoffrey Hinton have shown that it's possible. They first gathered data from subjects about rooms — kitchens, bedrooms, offices, living rooms, and bathrooms. They took 40 words associated with rooms and asked each subject whether each word was associated with each room. Then, they set up a network that had each of the 40 words represented by a single node. They set the weight of a connection between two nodes to correspond to the extent to which the two tended to be used together when a single subject described a single room.

The network uses Hopfield's energy-minimisation rule. When a single descriptor is 'clamped on' (ie, when its activation is permanently set to its maximum value), the system relaxes into one of five states, or rooms, since each room implies a constraint as to which words can occur together.

In the network, you don't explicitly define the schemata; you only set the associations between pairs of descriptors. The schema emerges out of the

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network as a natural consequence of its behaviour. Thus, the schemata are not explicitly represented in the network, but rather are simply patterns of activation across a set of descriptors.

This system has several nice properties. First, it explains how schema are activated when you have incomplete information — that is, why you think 'kitchen' when you see 'refrigerator'. This corresponds to the 'clamping on' of a single descriptor.

Since schemata are patterns rather than single units, this system allows for more flexibility in representing things. A slightly different version of a particular object can correspond to a slight change in the weights. And closely related schemata, such as 'woman' and 'girl', can overlap. In a more elaborate scheme, each descriptor in a schema can itself be a schema. The number of connections you need, however, rises quickly.

Cognitive hierarchies

Often neural-network models are ordered into hierarchies. Several levels exist in such a hierarchy, each composed of a set of units. Typically, units that receive input are at the bottom of the system, and units that give output are at the top. In a bottom-up system, units at each level connect to other units on their own level and influence units on levels above them. In a top-down system, units again connect to units on their own level but influence units on levels below.

Top down and bottom up are familiar concepts in cognitive science. For instance, in sentence perception, these terms refer to how different-size linguistic elements, the phoneme (sound), morpheme (word element), word, phrase, and sentence, interact with one another.

The HEARSAY-II speech-recognition program from Carnegie Mellon was one of the first AI programs to integrate knowledge from several levels, storing its results in a global data structure called the blackboard.

Does the overall perception of a word help you to perceive all the letters in it, individually, in a top-down fashion? Most psychologists would say yes. For instance, psychologists have done experiments in which they show subjects non-words like BCAK and PLAM; the subjects interpret these words as BACK and PALM. The theoretical explanation is that the units representing letters activate the units representing words in a manner that is somewhat insensitive to the letter's position in the

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word. The unit for the whole word actually influences the perception of the individual sound. Neural-network models exist that model this process and others like it.

For example, in McClelland's programmable blackboard model of reading, units for letters and units for words are connected by a grid. A connection in the grid between a letter and a word is set to a positive value if the letter is in the word, and to zero if it isn't. The letter units reinforce the word units in a bottom-up fashion, and the word units influence the activation of the letter units in a top-down fashion. Thus, the network converges to the perception of a single word at a time.

The programmable blackboard model does not handle the perception of individual letters, but you could readily add a third level to the system, a level of letter sub-features. Information would pass up and down in the network, from letter sub-feature to letter to word, and back down again.

A parallel reading network

One problem in creating a reading network is that people tend to read more than one word at a time. Since a single network reads only one word, it can't handle this. If the network tries to read more than one word, you get 'crosstalk'; that is, if the input words are 'bank' and 'lane', the network will perceive both the two inputs and 'lank' and 'bane' as well. As a solution, McClelland proposes duplicate copies of networks. Duplicate individual word-recognition networks would have programmable connections instead of hard-wired connections between letters and words.

In addition to programmable networks, you could have a hard-wired network that represents the relationships between letters and words. This network programs all the programmable networks via connections to them. Thus, you could represent knowledge centrally instead of having to duplicate it several times. You can save memory space by loading a programmable network with only knowledge relevant to processing the word it currently encounters. McClelland has worked out the details of his model thoroughly.

The programmable blackboard model accounts for psychological data concerning such things as parallelism in reading and word misperception. It shows how useful the psychological modelling approach to AI is: in explaining a good deal of psychological data with a model, we get a system that is quite good at the job at hand. McClelland has constructed a similar model of speech recognition and built a model of a higher-level process.

Processing sentences

One important aspect of sentence understanding involves determining the various roles that the different parts of a sentence play. For instance, consider the following two sentences:

The house rented for $2000.
The man rented the car.

In the first sentence, the house is the thing rented; in the second, the man is the agent of the rental. Yet in the two sentences, the nouns 'man' and 'house' are in the same position. Somehow, the model must discern their different roles.

McClelland and Alan Kawamoto have developed a connectionist system to do this role assignment. Words are described by 'semantic microfeatures' — basic dimensions that describe many objects and actions. For instance, two of the microfeatures describing nouns are human and softness, which have the values 'human, nonhuman' and 'soft, hard', respectively. Words are not directly represented in the system's networks, but in terms of the activations of units representing microfeatures.

The model has a group of units for each of the major roles that different nouns can play in an action. These roles are Agent (actor), Patient (acted upon), Instrument (thing used), and Modifier (adverbial word or clause). For instance, the sentence, 'The man ate the sandwich' would activate the microfeatures of 'ate' and 'man' in the set of units that corresponds to the Agent; this represents the fact that the Agent for the verb 'ate' is 'man'.

The system is trained on a series of sentences. The correct role assignments for the training sentences are shown to the system. These assignments correspond to the activations of particular nodes. The system adjusts the connections between these nodes so that they reinforce one another.

After being trained on a sufficient number of sentences, the system can make correct role assignments for new sentences. It can even make accurate role assignments for sentences with some syntactic ambiguity. For instance, in the sentence 'The man hit

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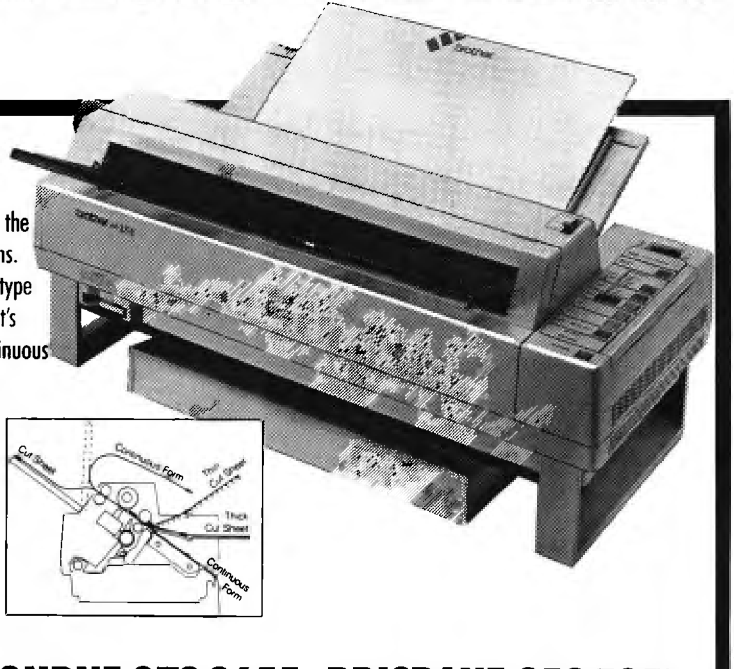

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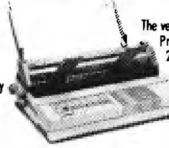

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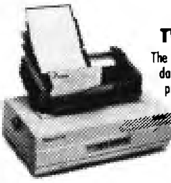

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the boy with the mallet', the system figures out that 'mallet' is the Instrument of 'hit' instead of belonging to 'boy', since 'mallet' has microfeatures that fit in well with it being an Instrument.

The system also handles a number of other problems well, and generally does a good job in assigning roles. McClelland and Kawamoto are currently considering ways of expanding their system into a more complete language-understanding model — for instance, one that includes a network to parse sentences.

The promise for the future

Neural networks are good for a variety of natural-language processing tasks, including letter recognition, reading, and sentence understanding. They are also useful in storing knowledge in schemata and in retrieving items from memory. They are not a cure-all for what ails AI and cognitive psychology, but they do bring a strong and biologically plausible new direction to many important problems.

Eventually, a connectionist model will probably be built of the natural-language-understanding process, since, as psychologists have shown, it involves integrating knowledge from many domains, including phonetics, morphology, syntax, and semantics. Connectionist models are particularly good at integrating these types of knowledge.

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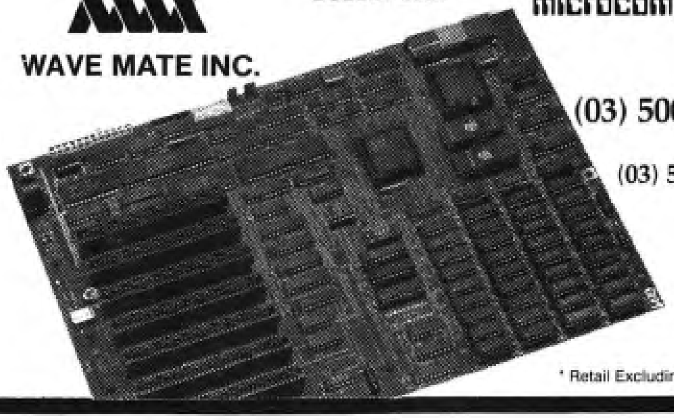

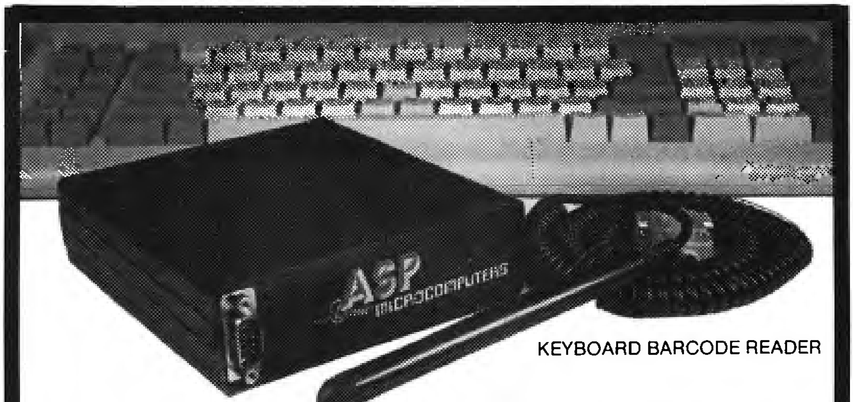

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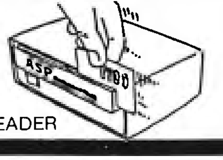

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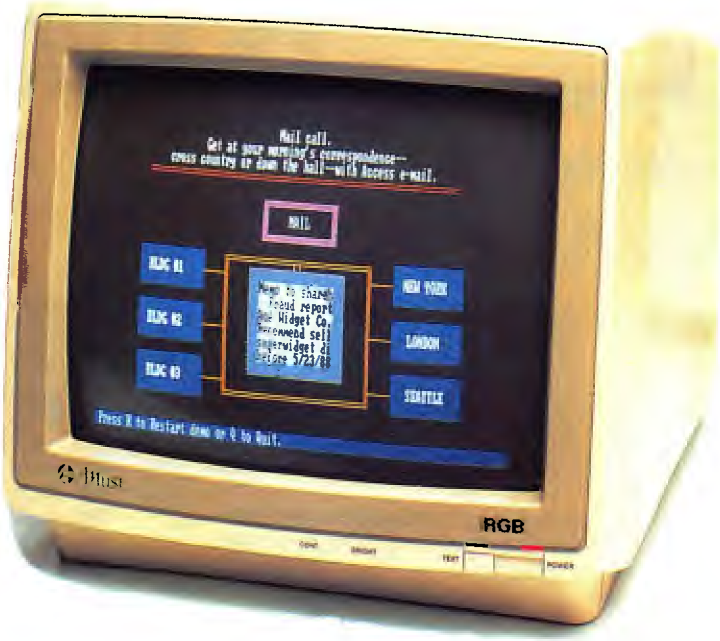
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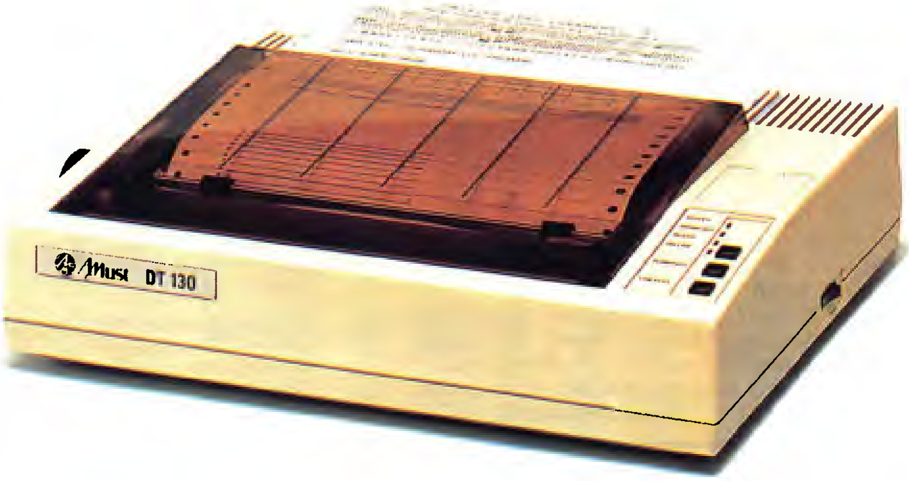
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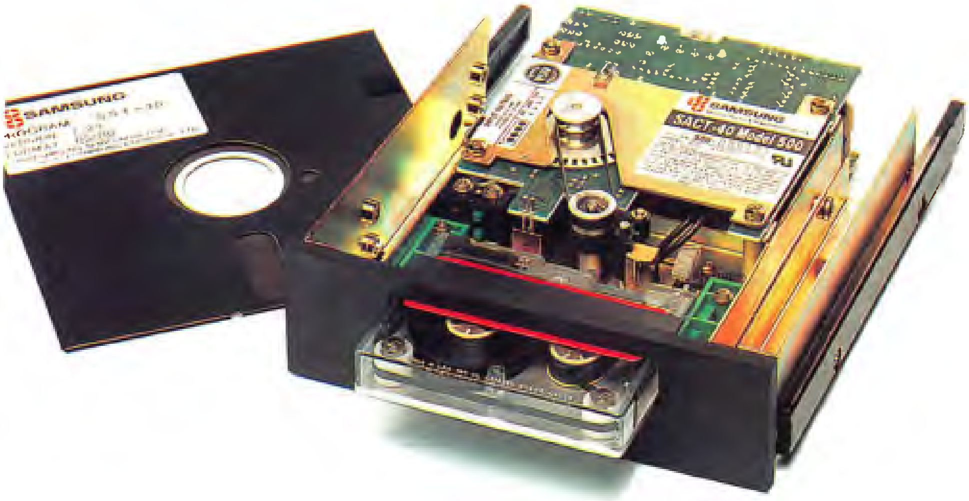
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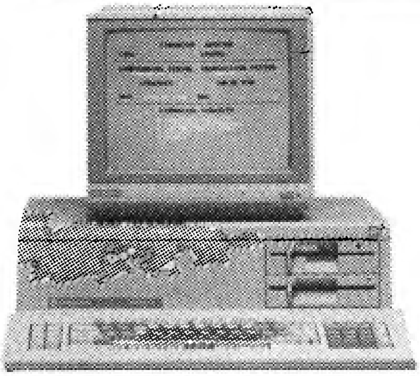

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Natural-language processing

Klaus K Obermeier presents an introductory look at some of the technology used in this area of artificial intelligence.

There are almost as many definitions of natural-language processing (NLP) as there are researchers studying it. But for purposes of simplicity, I will define NLP as the ability of a computer to process the same language that humans use in normal discourse.

NLP is generally divided into six major areas: (1) natural-language interfaces to databases, (2) machine translation — that is, from one natural language to another, (3) text scanning/intelligent indexing programs for summarising large amounts of text, (4) text generation for automated production of standardised documents, (5) speech systems to allow voice interaction with computers, and (6) tools for developing NLP systems for specific applications. According to the Clearinghouse for NLP at Battelle Columbus Laboratories, over 40 per cent of research activity is devoted to developing natural-language interfaces to databases. Machine translation and NLP tools each account for 20 per cent of the research. The remaining categories attract significantly less activity.

Approaches to NLP

The central problem for NLP systems is the transformation of a potentially ambiguous input phrase into an unambiguous form that can be used internally by a computer system. These internal representations, of course, vary from one application to another. As you can imagine, major problems arise if there is more than one potential interpretation of the input (as in 'List all employees broken down by sex') or if the input is somehow incomplete (eg, 'if y cn rd ths u r smrt').

The transposition from the potentially ambiguous phrase to the internal representation is known as parsing. The parse is actually derived from the Latin phrase *pars orationis* (part of speech). In NLP, parsing is usually a process of combining the symbols of a phrase into a group that can be replaced by another, more general symbol. This new symbol can in tern be combined into another group, and so on, until an allowable structure evolves.

> *'Pattern-matching programs without a grammatical basis proved to be of limited use.'*

Five different types of parsers have evolved: pattern-matching, grammar-based, semantic, knowlege-based, and neural-network parsers. Each one has a unique approach to NLP.

Pattern-matching approaches

Early natural-language programs were based on the idea that parsers can look for recurring linguistic patterns in a sentence without using any explicit grammatical formalism. During sentence analysis, the system merely looks for a possible match with a fixed number of patterns. If a match is found, the system performs a certain action (eg, rearranging the input according to another pattern). The process is similar to template-matching programs in other areas of AI (eg, vision).

ELIZA, the best-known pattern-matching program, was designed to simulate a Rogerian psychologist. The program, still popular today, was written by Joseph Weizenbaum in 1966. ELIZA consists of a set of patterns (see Fig 1), with each pattern having a number of replies associated with it. When a particular pattern is matched, the program selects one of the given set of replies and makes any necessary substitutions in that reply.

Pattern-matching programs without a grammatical basis proved to be of limited use. They are useful only if partial analysis is required or if only components of the system can make up for the loss of syntactic information. The basic concept of pattern matching, however, has been further developed and was used in semantic grammars, which I will discuss later.

Grammar-based approaches

The term grammar refers to a set of

rules that describes what sentences are part of a particular language. These rules are often called rewrite rules or productions. Two simple rewrite rules are as follows:

S → NP VP
S→ VP

These rules stipulate that a sentence (S) must have a noun phrase (NP) and a verb phrase (VP), or just a verb phrase by itself. With these rules you can build a tree structure showing unambiguously how the words in a sentence interact (see Fig 2). It is common practice to call the words at the ends of tree limbs 'terminals'. The other symbols in the tree, which are usually capitalised, are called 'non-terminals'. Rewrite rules usually establish how a non-terminal can be rewritten as a string of terminals or other non-terminals.

The noted linguist Noam Chomsky devised four types of grammar, based on the types of rules they used. The simplest grammar, Type 3, is also known as a 'finite-state'or'regular' grammar. It can produce only simple 'sentences.'

The Type 2 grammar is also known as a 'context-free' grammar. In this grammar, the left side of each rewrite rule can consist of only a single non-terminal symbol. Note that this symbol can always be rewritten as the right side of the rule, regardless of the context in which that non-terminal appears. [Editor's note: *Most syntactic parsers use a context-free grammar. See 'Natural-Language Processing in C' by Herbert Schild ,'also in this issue.*]

The next most complex grammar is a Type 1 or ' context-sensitive' grammar. In this type, more than one symbol can appear on the left side of the rewrite rule. There is only one requirement for these rules: there must be more symbols on the right side than on the left.

The most complex grammar, Type 0, has rules that do not follow any set pattern or requirements. This grammar is very difficult to parse. Indeed, researchers have proved that a Turing machine is required to process languages with this grammar.

Chomsky's major contention was that a natural language such as English could not be completely described by a context-free grammar, but required either a context-sensitive or a Type 0 grammar. There is an ongoing dispute in linguistics, however, as to whether English does in fact conform to a context-free grammar.

One argument in support of English being a context-sensitive language involves the fact that singular nouns and plural nouns require singular verbs and plural verbs, respectively. For example, the grammar in Fig 2 is a simple context-sensitive grammar. You can expand this grammar by adding two rewrite rules, both of which are allowable:

NOUN → programs
VERB → compile

Now, however, the grammar will allow a sentence that is not allowable in

```
Input Pattern:     (O YOU REMEMBER O)

  Replies:         (DO YOU OFTEN THINK OF 4)
                   (DOES THINKING OF 4 BRING ANYTHING ELSE TO MIND)
                   (WHAT ELSE DO YOU REMEMBER)
                   (WHY DO YOU REMEMBER 4 JUST NOW)
                   (WHAT IS THE CONNECTION BETWEEN ME AND 4)

Sample Input:      DO YOU REMEMBER LAST WEEK

Sample Response:   WHAT IS THE CONNECTION BETWEEN ME
                   AND LAST WEEK
```

Fig 1 ELIZA, one of the earliest natural-language processing programs, uses a pattern-matching parser to create responses to user input. The listing here shows one of the patterns used by the program and its replies. The word 'O' in the pattern will match with any number of words. The number 4 in the replies is substituted with the fourth element in the input pattern — that is, those words that correspond to the second O

Grammar:

S → NP VP
NP → DET NP1
NP → NP1
NP1 → ADJ NP1
NP1 → NOUN
VP → VERB ADV
NOUN → program
VERB → compiles
ADJ → new
DET → the
ADV → slowly

Sentence:

the new program compiles slowly

Tree:

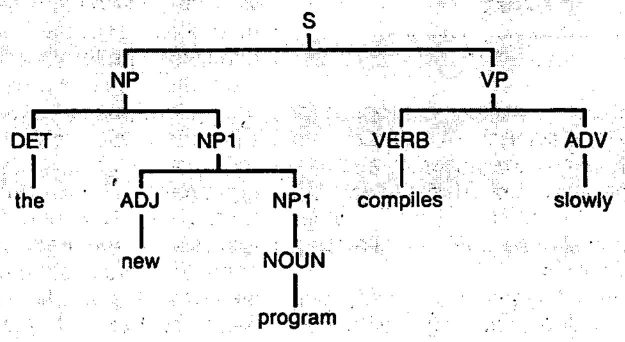

Fig 2 A simple sentence, a simple set of rewrite rules, and a tree drawn of the sentence using those rules. The symbols or words at the ends of each limb are terminals. The other symbols are called non-terminals. In this grammar, which is context-free, a single non-terminal is rewritten as one or more other symbols

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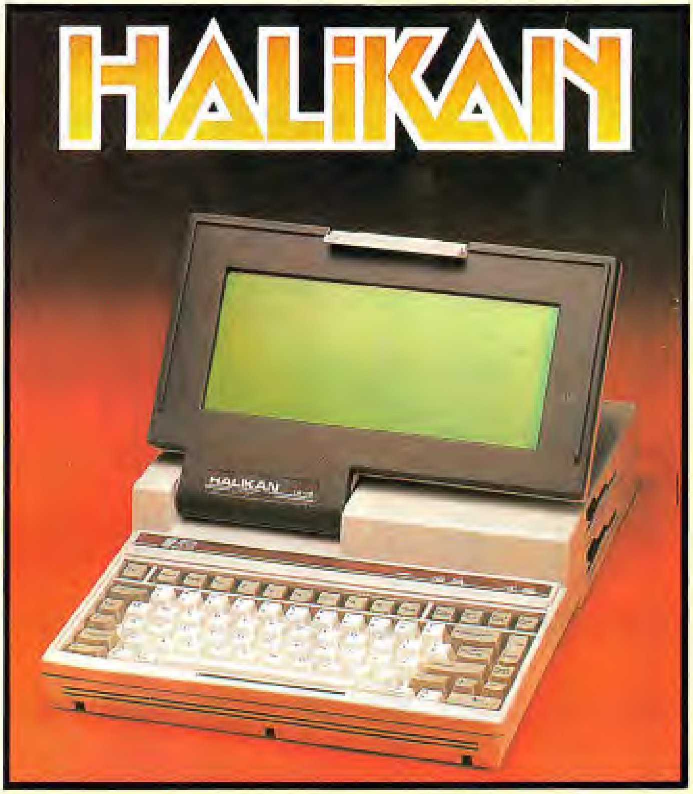

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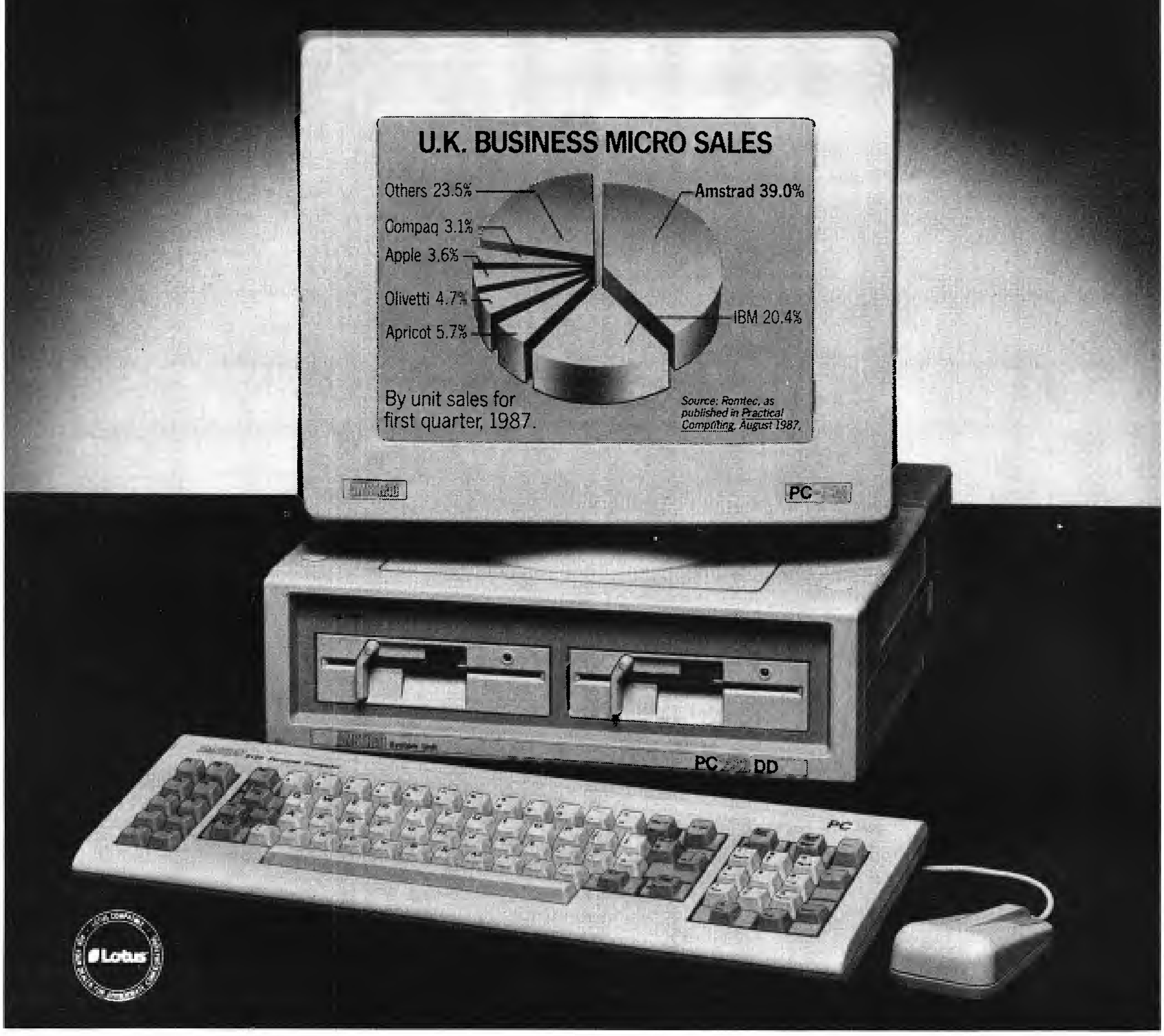
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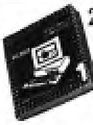

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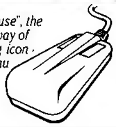

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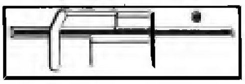

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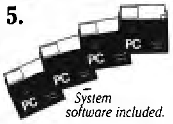

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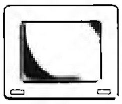

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English:
The programs compiles slowly.

You can add additional rules to the grammar that would disallow such sentences, but these rules would destroy its present simplicity. Other problems are caused by the word 'respectively' in sentences such as 'Singular nouns and plural nouns require singular verbs and plural verbs, respectively.'

Semantic approaches

The central role of meaning in understanding language has led some researchers to rely on predominately semantic rather than syntactic approaches. These researchers do not deny the need for some structural processing; rather, they use the syntactic analysis to complement their semantic considerations.

Two semantically oriented approaches to NLP are 'case grammar' and ' semantic grammar.'

Case grammar has been used in a number of NLP implementations since its development in 1968. The idea behind case grammar is that every sentence has an underlying representation of its meaning. This representation includes the verb and the various noun phrases related to the verb. For example in the sentence 'John opened the door with a key,' we designate 'John' as the agent, 'door' as the object, and 'key' as the instrument for the verb 'opened.' Note that the cases remain the same for the sentence 'The door was opened by John with a key.'

The founder of case theory, C Fillmore, referred to the relationships between these nouns and the verb as 'cases'. (You may recall that Latin and some modern languages have similar cases for nouns.) Fillmore postulated a number of cases, none of them occurring more than once in a sentence.

Semantic grammar consists of a lexicon and a series of rewrite rules. It is similar to a syntactic grammar, except that word classes (eg, NOUN, VERB) are replaced by specific semantic classes (eg, SHIPS, SHIP-PROPERTIES). The advantage of this approach is that the size of these semantic classes is much smaller than the size of an equivalent word class. This results in a much more efficient parsing strategy, since the program has to check a smaller number of possibilities. The disadvantage of semantic grammar is the difficulty of transferring rewrite rules from one domain of applications to another.

One of the most prominent implementations of semantic grammar was LADDER, developed in 1978 by Gary G Hendrix. LADDER was designed as a natural-language interface to a database for the US Navy. Fig 3 shows an example of some of the rewrite rules used by LADDER. Hendrix later went on to form the company Symantec and developed the database manager/word processor Q&A.

Knowledge-based approaches

Instead of relying solely on the structural or semantic information of a sentence, some NLP systems also have access to a knowledge base for a specific domain of knowledge. This contrasts with most grammar-based theories that look at NLP simply in terms of a set of rewrite rules for sentence-level processing.

```
Rewrite rules:

      S → what is SHIP-PROPERTY of SHIP?

      SHIP-PROPERTY → the SHIP-PROP | SHIP-PROP

      SHIP-PROP → speed | length | draft | beam | type

      SHIP → SHIP-NAME | the fastest SHIP2 | ...

      SHIP-NAME → Kennedy | Kitty Hawk | ...

Sample input:

      WHAT IS THE LENGTH OF THE KENNEDY?
```

Fig 3 Some of the rewrite rules used by the semantic grammar of the LADDER system. Note that semantic classes such as SHIP and SHIP-PROPERTY have replaced the word classes of Fig 2. The pipe symbol '|' designates 'OR'

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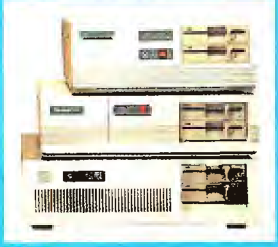

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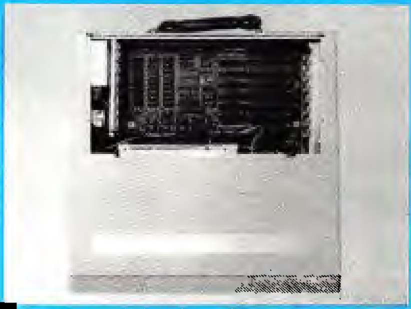

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FDD/HDD Adaptor	Supports 2 Floppy Drives (1.2MB & 360KB) and 2 Winchester Disks	
Floppy Disk Drive and Hard Disk	One 1.2MB 20 MB Hard Disk (Optional)	Two 360 Byte Teac Drives 20M Hard Disk (Optional)
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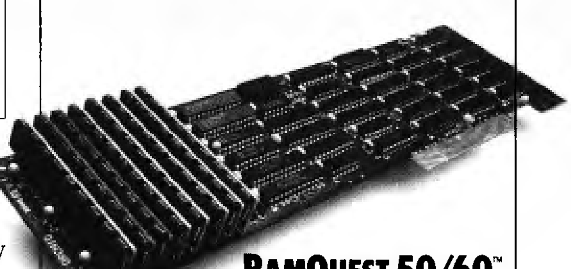

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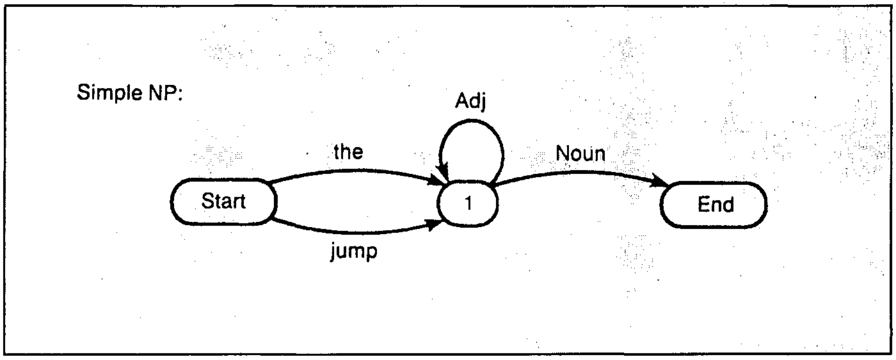

Fig 4 A transition network for a simple noun phrase. The computer begins at the state labelled 'Start' and moves to other states depending on how its input matches the labelled arcs. The arc labelled 'jump' is always taken if tested. Note that this network performs the same function as the rules 'NP' and 'NP1' in the grammar of Fig 2

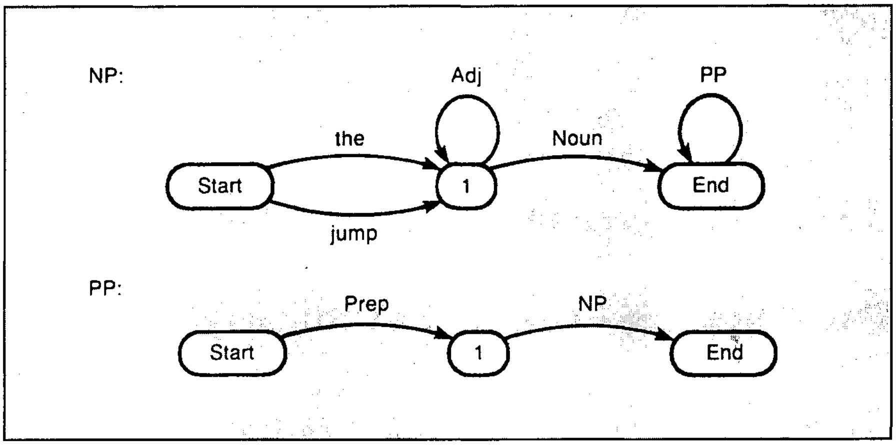

Fig 5 A set of recursive transition networks for a noun phrase (NP) and a prepositional phrase (PP). These networks can be called by other networks or by each other

One knowledge-based approach is called' word-expert parsing'. In this approach, the word is considered the basic linguistic unit. Linguistic knowledge is distributed among a group of procedural 'experts' that know how the interpretation of a word changes in particular contexts.

One argument in favour of this approach is the fact that words have a rich linguistic and conceptual structure. Also, it is unlikely that language can be reduced solely to a number of rewrite rules, as implied by most grammar-based theories.

Another knowledge-based approach is called 'conceptual dependency theory.' The central idea behind this theory is to create a canonical representation of a sentence, based on certain semantic primitives. A canonical representation is simply a basic way of representing the meaning of a sentence. Different sentences that mean the same thing will all have the same common canonical representation. For example 'Jean eats candy' and 'The candy was eaten by Jean' both share the same canonical representation: 'Jean ↔ INGEST ← candy.'

In this theory, semantic primitives are the most basic entities used to describe the world. Individual words can always be analysed further, but semantic primitives cannot.

The most prominent use of conceptual dependencies was done by Roger Schank in 1975. His idea of representing the meaning of a sentence such as 'Jean eats candy' is to postulate primitive actions to represent semantic relationships. These primitive actions include INGEST ('take something to the inside of an animate object') and MOVE ('move a body part'). Schank's original theory postulated only seven primitive actions. Five of these were for physical actions (PROPEL, MOVE INGEST, EXPEL, and GRASP). The remaining two were for describing state changes: PTRANS (physical transfer of location) and MTRANS (mental transfer of information).

In 1977, Schank integrated the theory of conceptual dependencies into his script theory. A script is a set of standarised perhaps oversimplified knowledge used for processing natural language. For example, a script for a restaurant would contain certain basic facts, such as:

S — Customer

Entry conditions:
S is hungry.
S has money.

Results:
S has less money.
S is not hungry.
S is pleased (optional)

The script also contains other information, such as what kinds of people or things are found in the restaurant, and what types of actions these people or things are allowed to do.

Neural-network approach

A fairly recent approach to NLP involves setting up a network of neuron-like computing units. Each unit has a number of inputs, a small set of possible states and an output that is a function of the inputs. Each input to the computing unit has a confidence value, which can vary from –1 to 1. When a computing unit is

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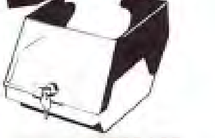

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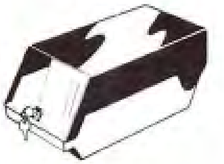

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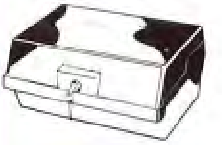

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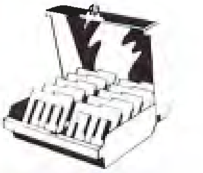

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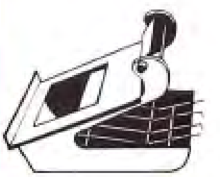

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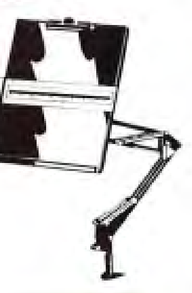

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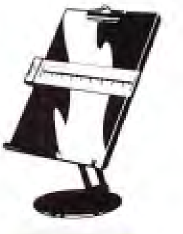

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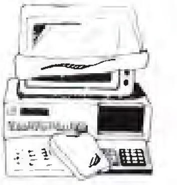

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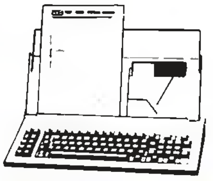

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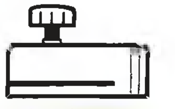

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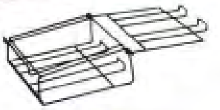

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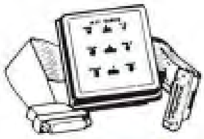

RS232 FAST CABLER

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SPECIFICATIONS:

Connector: DB25 plug on 100mm cable and DB25 socket on 100mm cable

Indicators: Tricolour LED's for pins 2(TD). 3(RD). 4(RTS). 5(CTS) 6(DSR). 20(DTR)

Switches: 3 Slide switches to swap leads.

Power: Interface power

Enclosure: Black, high impact plastic

Dimensions: 85 x 95 x 30mm

X15710 .... $145

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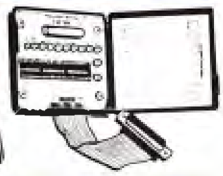

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Indicators: Tricolour LED's for TD. RD, RTS, CTS, DSR, CD, TC. RC, DTR, (E)TC.

Jumper Wires: 20 tinned end pieces

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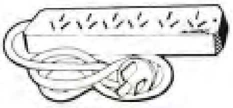

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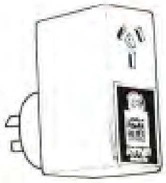

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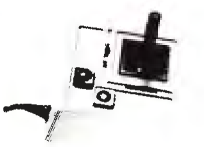

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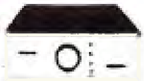

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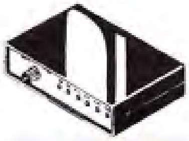

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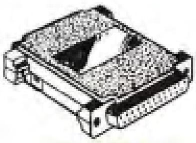

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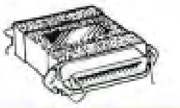

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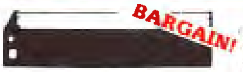

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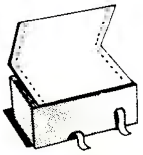

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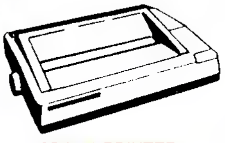

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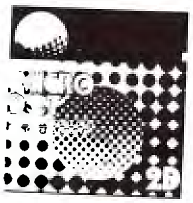

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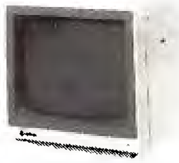

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- High contrast non-glare screen
- Excellent value for money!

SPECIFICATIONS:

Picture tube: 12" diagonal 90° deflection
Mode: TTL
TTL input signal:
Polarity: TTL Positive
Level: 4V p-p + 1 5V
Impedance: 75ohm
Video bandwidth: 16MHz (3dB)
Scanning frequency:
Horizontal: 18 432 + 0 1KHz
Vertical: 50HZ + 0 5%
Active display area: 216(H) x 160(V)mm
Display characters: 80 characters x 25 lines
Input connector: 9 pin connector
Controls:
Front; Power ON/OFF Contrast
Rear; V-Hold, V-Size Brightness
Internal; Vertical Linearity, Horizontal Linearity Horizontal Width Focus
Power supply: 110 120V 60Hz, 220 240V 50 Hz
Dimensions: 308(W) x 297(H) x 307(L)mm
Weight: 7 3Kg
Shipping weight: 8 3Kg

Cat No	Description	Price
X14500	(GREEN)	**$189**
X14502	(AMBER)	**$189**

SAMSUNG 12" 20MHz COMPOSITE MONITOR ONLY $149

FEATURES....

- High contrast non-glare screen
- High resolution, 80 or 40 character display

SPECIFICATIONS....

Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green (P39) or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0 5V-2 0Vp-p
Scanning frequency:
Horizontal: 15 734 KHz + 0 1%
Vertical: 60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast Brightness, H-Shift, V-Size
Inside: H-Width H V hold H/V linearity, Focus
Power supply: 110/120V 60Hz 220/240V 50Hz
Dimensions: 308(W) x 307(H) x 297(L)mm
Weight: 7 3 Kg
Shipping weight: 8 3 Kg

Cat No	Description	Price
X14514	(GREEN)	**$149**
X14516	(AMBER)	**$149**

SAMSUNG 12" FLAT SCREEN COMPOSITE MONITOR

FEATURES....

- Flat high contrast non-glare screen
- High resolution 80 or 40 character display
- Tilt swivel base
- Compatible with Apple* and IBM* colour composite signal

SPECIFICATIONS....

Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0 5-2 0Vp-p
Impedance: 75ohm
Scanning frequency:
Horizontal: 15 734 KHz + 0 1%
Vertical: 50-60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 character x 24 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch Contrast Brightness, H-Shift, V Size
Inside: H-Width, H/V hold H V linearity Focus
Power supply: 110 120V 60Hz 220 240V 50Hz
Dimensions: 310(W) x 307(H) x 300(L)mm
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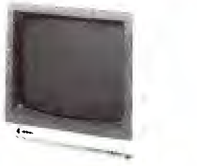
X14512	(AMBER)	**$189**



SAMSUNG 12" TTL/COMPOSITE MONITOR

FEATURES....

- At last a monitor with both TTL and Composite modes!
- High contrast non-glare screen
- High resolution 80 or 40 character display
- Swivel Tilt base

SPECIFICATIONS....

Picture tube: 12" diagonal and 90° deflection
Phosphor: Green (P42)
Video input signal: Composite TTL Switchable
Polarity: Negative Positive
Level: 0 5 - 2 0Vp-p 4 0 + 1 5Vp-p
Impedance: 75ohm more than 6 8K ohm
Scanning frequency:
Horizontal: 15 75 KHz + 0 1% 18 432KHz + 0 1%
Vertical: 47 63Hz
Video bandwidth: 20MHz
Active display area:
Composite 206(H) x 160(V)mm
TTL 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: Phono Pin Jack 9 pin D-Sub Connector
Controls:
Outside: Power Switch Contrast Brightness Signal Select V Hold V Size
Inside: H-Width H V linearity Focus H V Shift
Power supply: 110 120V 60Hz 220 240V 50Hz
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SPECIFICATIONS:

CRT: 14 inch (360mm) diagonal 90 degree deflection
Display Size: 245(H) x 180(V)mm
Phosphor: P22, non glare tinted screen
Dot Pitch: 0 31mm
Video Bandwidth: 18 MHz
Resolution: 15·75KHz - 640 x 200
21 85KHz 640 x 350
Input Signals:
1 RGBI positive, H(+) V(+)
2 RrGgBbI positive H(+), V( )
Input Impedance: TTL Level (330 ohms)
Dual Scanning Frequency:
Horizontal 15·75 KHz or 21 85 KHz + 10Hz
Vertical 50 - 60 Hz
Connector: 9 pin D-type
Size: 312(H) x 363(L) x 380(W)mm
Weight: 10 8 Kg (Net)

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SPECIFICATIONS:

CRT: 13 90° deflection colour
Input Signal:
Video Signal Separate video signal
Video Positive
Sync Positive
Input Level TTL Level
Scanning Frequency:
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Vertical 60Hz
Display Size: 245(H) x 182(V)mm
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activated, it evaluates all its inputs and weighs them according to their respective confidence values. If certain conditions are met, the computing unit generates an output value that is used as input by other computing units. Note that only the confidence values of the inputs may be changed during 'learning'; the connection pattern is 'prewired.'

This type of system is usually called a neural-network or 'connectionist' approach. The fundamental premise of the approach is that the individual units do not transmit large amounts of data but compute simply by being connected to a large number of similar units.

The neural-network parsing model contains three levels of 'neurons.' The first level is the lexical level, which serves as the input level of the network. Here, the neurons are mapped to particular words. On the second level, the wordsense level, the inputs from the lexical level are combined to activate neurons that represents the meaning of the words. On the third, case-logical level, the meanings are combined to form predicates and objects.

Neural-network parsing comes closest to modelling human linguistic information processing, based on neurological evidence. It is, however, still at the beginning stage of research. For a description of neural-network parsing, see 'Toward Connectionist Parsing' by Small, Cottrell, and Shastri. [Editor's note: *See also 'Modelling the Brain' by Matthew Zeidenberg in this issue.*]

Parsing techniques

Once a natural-language developer has decided on a particular parsing approach, he or she must then choose a parsing technique or formalism. Parsing techniques fall into two groups: nondeterministic and deterministic. The non-deterministic parsers can be further divided into top-down and bottom-up parsers. Other specialised parsing techniques are based on combinations of these three major types.

Top-down parsers try to match the grammar rules against the input, starting at the topmost rewrite rule (which usually involves the start symbol or sentence symbol S) and recursively moving toward lower, more specific rewrite rules. The parse is successful if a sentence can be constructed that matches the input sentence.

Top-down parsers are easy to write and modify. Rules that are most likely to be used can easily be placed ahead of less likely rules, enhancing performance. And the number of generated sentences can be arbitrarily limited.

Top-down parsers can be slow, however. If all the rules at a particular level fail, the parser backtracks up to the previous level to try another rule there. During backtracking, the same constituents may be analysed many times. Top-down parsers also have trouble handling ill-formed input and require a separate module to decide which of several successful parsers is the best.

Bottom-up parsers start by combining the lowest-level elements first and then building up larger constituents. For example in the simple grammar in Fig 2, the first steps of a bottom-up parser would be to substitute the non-terminal DET for *the;* ADJ for *new;* NOUN for *program;* and NP1 for ADJ NOUN.

Bottom-up parsers can at least partially parse ill-formed input. Also, scoring mechanisms can be applied to reduce the combinatorial explosion of possible parses. Since bottom-up parsers are not goal-directed, however, they generate numerous spurious parses. And the correctness of the parse can be determined only after all the parses are performed.

Deterministic parsing is different from top-down and bottom-up parsing in that

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there is no backtracking. Deterministic parsing is also called wait-and-see parsing (WASP). The technique creates new nodes in a bottom-up fashion but uses a limited look-ahead feature to determine which node to use. One advantage of a deterministic parser is increased speed because it avoids the combinatorial explosion of possible parses. The disadvantage is that the algorithm is based solely on syntactic information.

The best known of the deterministic NLP systems was PARSIFAL, created by M Marcus in 1980. One result of PARSIFAL was a clear delineation of when such a parser would have to use nonsyntactic information to analyse input.

Augmented transition networks

Although first developed in 1970, the augmented transition network (ATN) is still the most widely used technique for NLP. But before I describe ATNs, I'll discuss transition networks.

A transition network consists of a series of states connected by arcs (see Fig 4). Each arc is labelled by a word category (eg, noun or verb) or a specific word. The program starts at a given state and then checks the next word in the input string for a match with one of the arcs. If a match is found, the program proceeds to the next arc, and thus 'traverses the network.'

The advantage of transition networks is that they can be easily implemented on a computer. Each state can be implemented as a function that checks its input against the arcs emanating from that state. If a match is found, the function (or state) at the end of that particular arc is called.

Recursive transition networks have an additional feature in that some arcs may be labelled with other, subordinate, transition networks (see Fig 5). These arcs let a given network call another network or even call itself recursively. Usually these arcs are labelled with non-terminal symbols (eg, PP for prepositional phrase). These networks are considerably more powerful than transition networks.

Even more powerful are augmented transition networks. ATNs are similar to recursive transition networks but have three additional features: registers, which can store conditions or information on a global basis, regardless of which particular sub-network is being processed; conditions, which let arcs be selected if registers indicate certain conditions; and actions, which let arcs modify the structure of data.

Note that the arcs in an ATN can be labelled, not only with words, word classes, and non-terminals, but also with arbitrary tests that depend on the state of the global registers. These global registers and their associated tests make it possible for the program to go beyond checking only adjacent elements. Obviously, being able to store and act on these conditions makes possible a much more efficient parsing than earlier transition networks did. For example, the presence of a form of the verb 'be' before the main verb in a sentence can set a trigger to check for the preposition 'by,' which in turn can corroborate evidence for a passive or an active sentence.

Although ATNs are powerful, they experience problems with ungrammatical sentences for which no relevant networks have been provided. If the program encounters a construction for which it does not have a structural description, it simply stops.

Chart parsers

The chart-parsing idea was implicitly stated in a classic paper by J Earley in 1970 on context-free parsing algorithms for compilers and compiler generators.

A chart parser combines the constituents of the input sentence according to the rules of a particular grammar. It combines these constituents as they are encountered and stores the output in a well-formed substring table (the chart). The parsing mechanism keeps track of the constituents it has built and the contexts in which they are expected. This means that no work needs to be duplicated for combining words that potentially are part of several parses. A chart parser combines the flexibility of control of a top-down parser with the data-driven processing power of a bottom-up parser.

One advantage of a chart parser is that it can be used with any of several grammatical formalisms, rule invocation strategies, and search strategies. With this flexibility, however, comes the disadvantage that the program must record all plausible and implausible parses, leading to increased storage requirements.

The future

Market predictions are hard to make for an area of R&D as embryonic as NLP. Many of the scenarios that have been proposed feature an overly optimistic prognosis. A case in point is a prediction by the newsletter *Artificial Intelligence Markets* in August 1985 that revenues for NLP software would grow by 200 per cent between 1984 and 1985. Actual growth was around 100 per cent. For 1986, AIM predicted a mere 20 per cent increase. AIM also predicted that approximately 450,000 personal computer software packages with integrated NLP capability will be shipped by 1990.

Numbers, however, can be misleading, success stories subjective, and claims often too optimistic. In brief, NLP technology is still too young to allow firm long-range predictions. But, comparing current market studies with the information from Battelle's Clearinghouse for NLP corroborates the abovementioned trend toward the personal computer and integration in everyday applications software.

In the long run, progress will be influenced primarily by unforeseeable innovations in both software and hardware and maybe netware.

Intelligent user interfaces of the future will require capabilities for both the understanding and the generation of natural language. The market potential for NLP products will further increase if a common standard can be established. This common standard would let users access different programs and databases through the same interface. NLP tools will become more popular, depending on the demand for better interfaces to many different software packages. Customisation and integration will play a role, since the applications program is only as good as its interface.

A science by itself

NLP has been a controversial issue for the fields of both AI and linguistics. AI research was said to be practical but untheoretical, whereas research within linguistics was theoretical but impractical. The eclectic nature of NLP research has to give way to a more autonomous discipline dealing exclusively with the issue of natural-language understanding by biological and electronic organisms. Current NLP research is caught between the ideologies of the various academic disciplines. NLP systems of the future have to be based on more innovative linguistic and conceptual models if they are to become useful and accepted on a large scale.

Bibliography

Barr, A, and E A Feigenbaum. *The Handbook of Artificial Intelligence,* vol.

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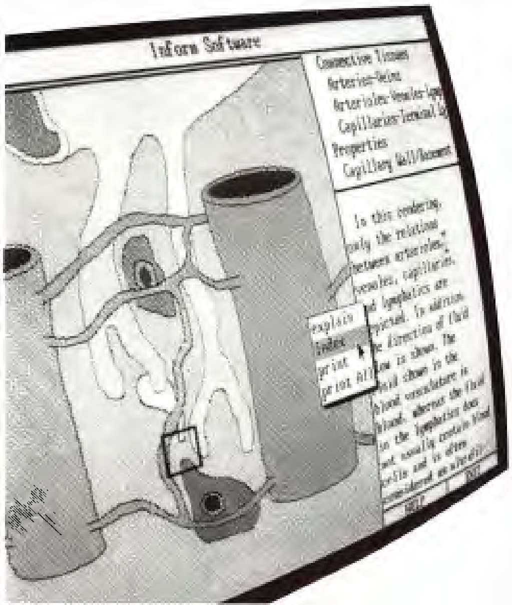

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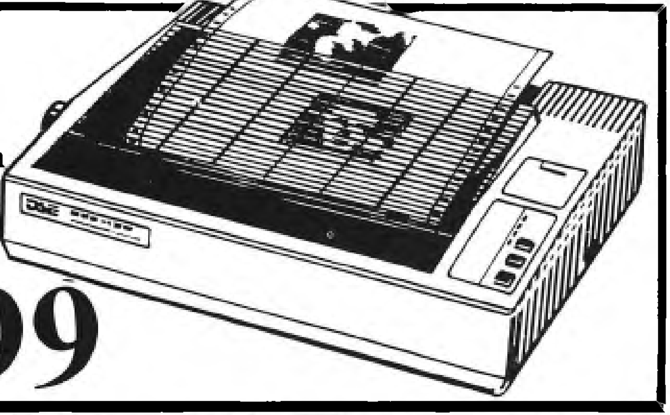

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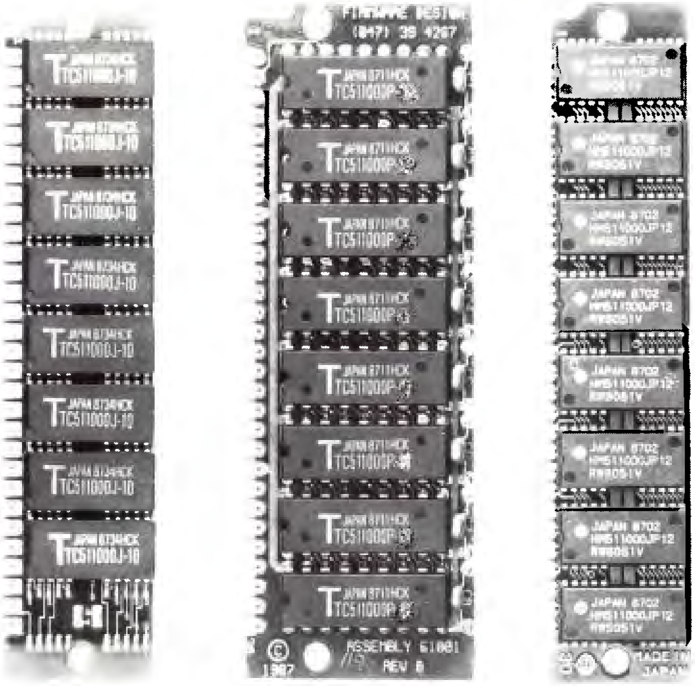

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Natural-language processing in C

Herbert Schildt examines a simple context-free recursive-descent parser that opens the door for computer comprehension of human language.

Natural-language processing (NLP) may be the most important task that artificial intelligence can solve because, once accomplished, NLP would open the door for direct human-computer dialogues, bypassing normal programming and operating-system protocol. NLP is a 'doable' task, but the sheer size and complexity of human language has kept it from being fully accomplished. This article develops a simple natural-language parser that can serve as the starting point for your own NLP program.

What is NLP?

NLP tries to make the computer capable of understanding commands written in standard human languages. (This article assumes that English is the human language being processed, but you can apply all the concepts that are presented to any other language.) A somewhat less important part of NLP is making the computer construct natural-language-like responses. After the computer understands natural language, it is a small step to generating responses.

In my opinion, speech synthesis and recognition are not actually part of NLP. A natural-language processor doesn't care how a sentence is input into the computer; its job is to extract information from that sentence.

While NLP has no direct use of its own, except for research, it can provide a front end for other computer programs — especially database managers and generalised problem solvers. Many programmers are interested in NLP-driven operating systems, which would virtually eliminate the time it takes to learn to use the computer. Context-sensitive foreign-language translators need NLP in order to produce accurate translations; and NLP is essential to autonomous robots, which must effectively interact with a human world.

Approaches and constraints

There are two opposite approaches to NLP. One approach attempts to use all the information in a sentence, just as a human would. Its goal is to make the computer capable of carrying on a conversation. However, this is quite difficult to accomplish. The other approach tries to let the computer accept natural-language commands, but only to extract information essential to that command — a much easier task to program. The parser presented in this article has a slim chance of reaching the first goal; it has a much more probable chance of accomplishing the second.

One of the most difficult aspects of constructing an NLP-driven system is the complexity and flexibility of human language. When you implement a natural-language processor, it is tempting to try to restrict the type of sentences that the processor will understand to a subset of the natural language. If you restrict the grammar, your task becomes much easier, and, if done correctly, the restriction is barely noticeable. Therefore, let's assume that all sentences are declarative, not interrogative, and that they generally follow the standard form: subject, verb, object.

Let's also assume that all adjectives precede the nouns they modify, all adverbs follow the verbs they modify, and all sentences end with a full stop. With these constraints, the following sentences are valid: 'The child runs to the house.' and 'The large child runs quickly to the window.' However, a sentence such as 'The child quickly runs to the house.' is invalid because the adverb 'quickly' precedes the verb 'runs.' Let's call our restrictive set of rules the G1 grammar.

In addition to rules, you need a

Word	Type
door	noun
window	noun
house	noun
child	noun
has	verb
runs	verb
plays	verb
large	adjective
quickly	adverb
the	determiner
a	determiner
to	preposition

Table 1 The words that our parser will understand

vocabulary. For our purposes, let's keep the number of works to a minimum, but you are free to add to the list if you like. Our parser will recognise only the words shown in Table 1.

The state-machine parser

The core of any NLP system is the parser, the section of code that reads each sentence, word by word, to decide what is what. One approach to parsing, the state-machine parser, uses the current state of the sentence to predict what type of word can legally come next. A state-machine parser is a directed graph that shows the valid transitions from one state to another. For example, a noun can legally be followed only by a verb or a preposition (see Fig 1).

The worst problem with the state-machine parser is its complexity; even for the simplest grammar, you need several separate conditional statements to determine whether a state transition is legal. Imagine how many states you would need to define the entire English grammar! Another problem is that the state-machine parser doesn't know how it got to any particular state. In other words, you can't call on a state-machine parser to supply any information other than its current state.

On the plus side, state-machine parsers are ideal for certain specific needs, such as job-control languages and some database applications. In these environments, you need only ensure that the user enters the commands in a valid format and that the computer knows each word. State-machine parsers can work in these situations because they have few valid types of sentences and, thus, few states.

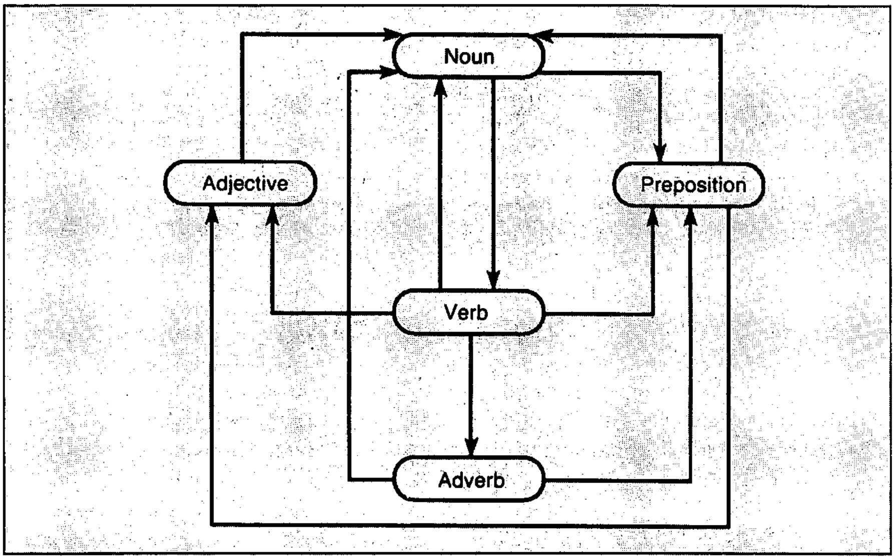

Fig 1 The state-machine parser for the restricted G1 grammar

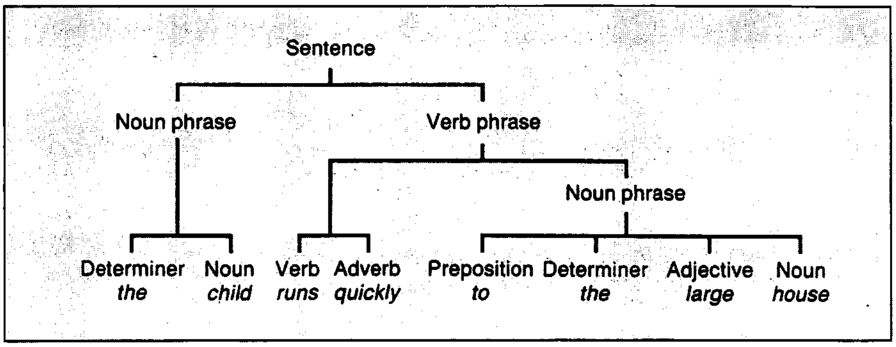

Fig 2 A tree structure that parses the sentence 'The child runs quickly to the house'

The context-free parser

To understand context-free parsers, you must look at sentence construction completely differently from the way you do for the state-machine model. You must think of the sentence as being composed of various items, each of which is composed of other items, and so on, until you break the sentence down into its atomic elements (eg, noun, verb, and adjective). The rules that govern how each item can be constructed are called the production rules of the grammar. A context-free parser uses these production rules to analyse a sentence.

The production rules for the G1 grammar are as follows:

SENTENCE → NP + VP
NP → determiner + noun
NP → determiner + adjective + noun
NP → preposition + NP

VP → verb + NP
VP → verb + adverb + NP
VP → verb + adverb
VP → verb

where the right arrows stands for 'produces,' NP for 'noun phrase,' and VP for 'verb phrase.' The noun phrase is a recursive definition for a prepositional phrase; the verb phrase is indirectly recursive, because it evokes a noun phrase as part of its definition.

Fig 2 shows how to apply these rules to a sentence. The production rules form a sort of tree, often called a parse tree, which represents how the parser sees the sentence. A parser that generates this type of parse tree is called context-free, because the tree is not based upon the context of each element. The rules will work for any sentence that conforms to the G1 grammar, without regard to the context of each phrase.

NLP programs are not the only ones to use context-free parsing; virtually all computer languages use it. For example, you can parse Pascal, Basic, C, Modula-2, and others with a context-free parser. However, the fact that you can represent even a subset of English with production rules that a context-free parser can parse has enormous implications.

First, it asserts that, in some ways, English conforms to a strict set of rules — that is, English is not just a jumble of disconnected arbitrary restrictions. Second, it lets you apply some well-understood parsing techniques that were developed for computer languages to natural language — you don't have to reinvent the wheel. Finally, because context-free production rules are organised from phrases down to the words that ac-

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tually compose them, you can easily extract not only individual words, but also whole phrases. Thus, you can parse individual words as well as phrases — and know where each phrase came from; this gives you the basis from which you can gather semantic information. All these points make a context-free parser a big step forward from the state-machine parser.

```
/* structure of the word database */
struct word {
  char word[20];
  char type;
};
struct word wdb[MAX];  /* array of db structures */
```

Listing 1 The database for the G1 grammar defined as an array of structures

```
/* return one token from the input stream */
get_token()
{
  char *p;
  p=token;
  /* skip spaces */
  while(*t_pos==' ') t_pos++;
  if(*t_pos=='.') {
    *p++='.';
    *p='\0';
    return;
  }
  /* read word until a space or period */
  while(*t_pos!=' ' && *t_pos!='.')  {
    *p=*t_pos++;
      p++;
  }
  *p='\0';
}
```

Listing 2 The function get_token(), which reads the input sentence one character at a time until it encounters a space

```
/* Context-free recursive descent NLP parser */
parse()
{
  if(!nounphrase()) return 0;
  if(!verbphrase()) return 0;
  if(!terminator()) return 0;
  return 1;
}
/* read a noun phrase from the input stream */
nounphrase()
{
  char type;
  get_token();
  type=find_type(token);
  switch(type) {
    case DET:
      get_token();
      type=find_type(token);
      if(type==NOUN) return 1;
      else if(type==ADJ) {
        get_token();
         type=find_type(token);
         if(type==NOUN) return 1;
      }
      break;
    case PREP:
      return nounphrase();
  }
  return 0;
```

Listing 3 The parse() function for a context-free recursive-descent parser. This function is found in NLP.C

Recursive descent

There are many ways to implement a context-free parser that uses the G1 production rules. The easiest, especially in C, is to create a recursive-descent parser that uses a collection of mutually recursive routines that descend through the production rules until they completely parse the sentence.

Before you can implement a context-free parser, you must define a database to hold the vocabulary and the types of words that the parser can recognise. Listing 1 defines this database as an array of structures. The parser also needs a routine to break a sentence into its components. The function get_token() in listing 2 accomplishes this: get_token() reads the input sentence one character at a time until it encounters a space. The characters that are read form the next word in the sentence. Then, get_token() places this word into the global string token. A global variable t_pos holds a pointer to the input sentence and is incremented as each word is read.

Using get_token(), you can write the context-free recursive-descent parser in listing 3. At the topmost level, a sentence comprises a noun phrase, a verb phrase, and, in this case, a full stop as a terminator. Therefore, the function parse() calls the routines nounphrase() and verbphrase(). If you assume that these succeed, implying that the sentence meets the G1 grammar rules, then the parser calls terminator() to confirm that the sentence ends with a full stop. The functions nounphrase() and verbphrase() use their various support functions to implement the context-free rules as described above. If a sentence doesn't conform to these rules, then either nounphrase() or verbphrase() will fail, causing the parser to reject the sentence.

For example, let's see how the parser parses the sentence 'The child runs quickly to the large house.' First, parse() calls nounphrase(), which succeeds, because it finds both the determiner 'the' and the noun 'child.' Then parse() calls verbphrase(), which calls

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```
}
/* read a verb phrase */
verbphrase()
{
  char type,*pos;
  get_token();
  type=find_type(token);
  if(type!=VERB) return 0;  /* must start with a verb */
  pos=t_pos; /* save current position for backtracking */
  /* verb + adverb + NP */
  if(verb_adv_np()) return 1;
  /* verb +NP */
  t_pos=pos;  /* back up */
  if(verb_np()) return 1;
  /* verb+adverb -- no NP */
  t_pos=pos;
  if(verb_adv()) return 1;
  /* just verb */
  return 1;
}
verb_np()
{
  /* verb + NP */
  return nounphrase();
}
verb_adv_np()
{
  char type;
  get_token();
  type=find_type(token);
  if(type==ADV && nounphrase()) return 1;
  return 0;
}
verb_adv()
{
  char type;
  get_token();
  type=find_type(token);
  return (type==ADV);
}
terminator()
{
  get_token();
  return(find_type(token)==TERM);
}
```

```
/* read a noun phrase from the input stream */
nounphrase(s)
char *s;
{
  char type;
  get_token();
  type=find_type(token);
  switch(type) {
    case DET:
      strcat(s,token);
      strcat(s," ");
      get_token();
      type=find_type(token);
      strcat(s,token);
      strcat(s," ");
      if(type==NOUN) return 1;
      else if(type==ADJ) {
        get_token();
        strcat(s,token);
        strcat(s," ");
        type=find_type(token);
        if(type==NOUN) return 1;
      }
```

Listing 4 The nounphrase() function for a contex-free recursive-descent parser that displays phrases. This function is found in NLPRPT.C

verb_adv_np() to see if the verb phrase consists of a verb followed by an adverb, which in turn is followed by a noun phrase. In this case, the verb phrase does contain these: the verb 'runs' is followed by the adverb 'quickly,' which is followed by the prepositional noun phrase 'to the large house.'

Next, this prepositional noun phrase causes nounphrase() to call itself recursively. After the parser reads the final phrase, all the recursive calls unravel, and verbphrase() succeeds, returning a parse(). The parser confirms that a full stop ends the sentence by using terminator(). Finally, parse() succeeds, implying that the sentence satisfies the rules of the G1 grammar.

The context-free recursive-descent parser is expanded to an entire program in NLP.C. To better understand its operations, try it with several different sentences.

[Editor's note: *NLP.C and NLPRPT.C are available in Microsoft C 4.0 source code for the IBM PC AT and compatibles down-loadable by modem from Microtex on Telecom's Viatel (page *6663#), or by sending a blank formatted disk with a stamped self-addressed packet to 'NLP,'* C/-APC, *124 Castlereagh Street, Sydney 2000.*]

By slightly modifying parse(), nounphrase(), verbphrase(), and their support functions, these routines can break sentences into their component phrases.

Unlike the state-machine parser that could deal only with words, the context-free recursive-descent parser can extract phrases. This is an important capability, because it opens the door to the computer actually comprehending, rather than simply verifying, a sentence; this has the effect of letting the computer work with related groups of words.

Listing 4 contains the noun-phrase parser revised for phrase extraction. The program using the phrase-extraction version of the complete parser, including revised versions of parse(), nounphrase(), and verbphrase(), is called NLPRPT.C. It returns both the noun phrase and the verb phrase of a sentence. If you run NLPRPT.C with the input sentence 'The child runs quickly to the house.', your output will be

```
noun phrase: the child
verb phrase: runs quickly to the
             house
```

```
        break;
      case PREP:
        strcat(s,token);
        strcat(s," ");
        return nounphrase(s);
    }
    return 0;
  }
```

Pros, cons, and possibilities

The context-free parser has many advantages. First, it is easy to implement in C. Second, you can use it to deal with a sentence on both the word level and the phrase level. Third, it knows where it is in the sentence at all times. This differs from the state-machine parser, which has no idea where it actually is in a sentence.

The main disadvantage of context-free parsers is that they can't handle the many valid ways in which an English sentence can be constructed. It's easy to define a set of production rules that fully describe the simple G1 grammar, but for real-world English (or any other language), the production rules would be very complex, which could lead to a combinatorial explosion, perhaps making this method impossible to use.

The context-free parser in listing 3 — and in NLP.C and NLPRPT.C — is just a starting point intended to excite your imagination. I encourage you to enhance and evolve it to suit your needs. One thing you will probably want to do is include additional production rules in the parser so it can recognise a wider variety of English grammar. You will probably want to add better error checking, too. Also, although fully adequate for demonstration, the database that holds the words in Table 1 is simply an array of structures in which the words are stored in no special way. You will probably want a sorted, tree-based database that will allow fast lookups for several hundred — or several thousand — words.

END

This material is adapted from Artificial Intelligence Using C by Herbert Schildt.

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HyperCard

Apple's new trump card, HyperCard, extends the Macintosh user interface and makes everybody a programmer. Gregg Williams explains.

Many people are confused by Apple's new program, HyperCard. If you ask three different HyperCard users what it is, you might get answers like these:

"I don't know, exactly," person A says. "But I started playing with it, and I found I could keep my address book in it. I also keep my appointment book and to-do list in it. You can get from one of these things to another just by clicking on a little picture of it."

Person B is more certain. "It's something you have to have on disk to run these commercial programs they call 'stackware'. I use it to run this really great personal finance program I bought at a computer store."

"It lets you write your own programs," says person C. "I just wrote one that spells out words when my daughter clicks on them with the mouse."

Because HyperCard can be such different things to different people, it is hard to describe it accurately. To quote Apple's press release, "HyperCard is a personal toolkit that gives users the power to use, customise, and create new information using . . . text, graphics, video, music, voice, and animation. In addition, if offers an easy-to-use English-language-based scripting language [called HyperTalk] that gives users an opportunity to write their own programs." Apple calls it system software, meaning software that doesn't do anything by itself, but which must be present to provide support for other programs. Some third-party software developers call it unfair competition that destroys the market for their products. Both groups are partly right — and partly wrong.

Apple intends to make HyperCard as much a part of the Mac as a one-button mouse or a desktop with icons on it. To do this, it is bundling HyperCard free with every Macintosh Plus, Mac SE, and Mac II (you need at least 1Mbyte of memory, the 128k ROM, and either two 800k floppy disk drives or one floppy disk drive plus a hard disk drive). Current Macintosh users can buy HyperCard (four disks and a manual) for $99.

Overview

You can think of HyperCard as a stack of index cards. A group of related cards and the file that contains them are collectively called a stack. You will also hear such a file being called 'stackware' because, with HyperCard as an engine 'underneath' it, a stack looks exactly like your average Macintosh application. A card can contain text and graphics in very rich combinations, and information can belong to either the entire stack or a single card.

HyperCard stores text in fields, which can be any of several types. A field contains text of one font, size, and style. The bad news is that you can't alter the font, size, or style of individual words or sentences — all the text in a field must be the same. The good news is that one of the field styles is a scrolling text window, meaning that any HyperCard 'card' can hold as much text as you want.

Another important element of a card is that it can contain buttons. Yes, these look like the same buttons you find throughout all Macintosh applications: rounded-rectangle buttons, radio buttons, check boxes, and so forth. Things happen when you click a button — anything from going to the next card to returning to the Home stack (a 'Central Station' within HyperCard that you can always return to — see Fig 1) to playing a piece of music or a digitised voice file. Buttons, which always have a rectangular 'active area', can also be invisible (Apple calls them transparent); these can affect the stack's behaviour without the user ever knowing that they're present.

Cards are 342 pixels high by 512 pixels wide — the same size as a Mac Plus screen — and contain any graphics and text you want. Through powerful extensibility built into HyperCard itself (discussed later), you can also attach animation, sound, and music to a card, and you can control just about any device that you can connect to a Macintosh.

The 'About HyperCard . . .' box is two screens long and filled with names, but a few stand out. HyperCard is the brainchild of Bill Atkinson (creator of the Mac's internal QuickDraw code and of MacPaint), with additional programming and support by Dan Winkler (HyperTalk), Carol Kaehler (help files), Ted Kaehler and Mark Lentczner (sound support), Adam Paal (printer support), and Chris Espinosa and Mike Holm (product managers).

To make HyperCard practical in terms of size and speed, Atkinson developed proprietary algorithms for quick text searching and for the compression and decompression of graphic images. As an example of how fast it is, I created an 'address book' stack with 4277 addresses and phone numbers on it (the stack was 778k); HyperCard found the desired data on the last card in the stack exactly two seconds.

The six faces of HyperCard

Atkinson designed HyperCard so that it appears simple to novice users and powerful to sophisticated users. You can use HyperCard at one of five levels (with a sixth level available to programmers).

At the lower levels, menus shorten and disappear to make HyperCard look simpler. You can change the level you're in by clicking the appropriate radio button in the 'User Preferences' card, which is the last one in the Home stack.

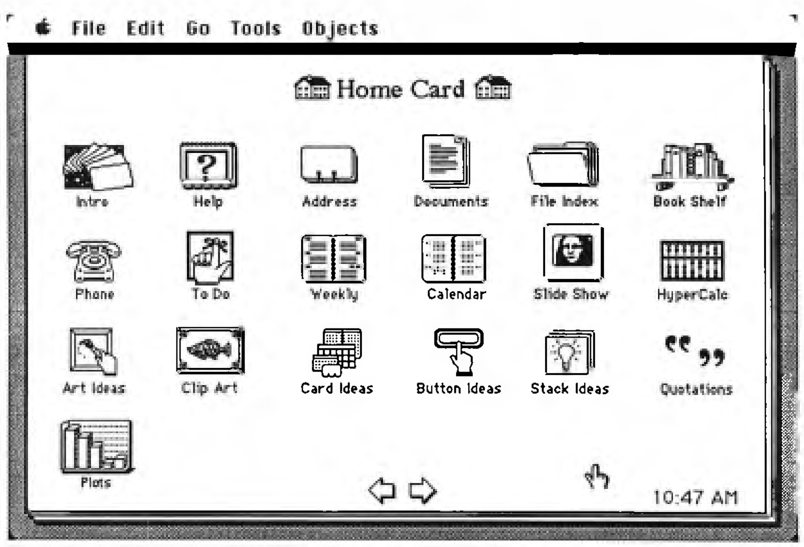
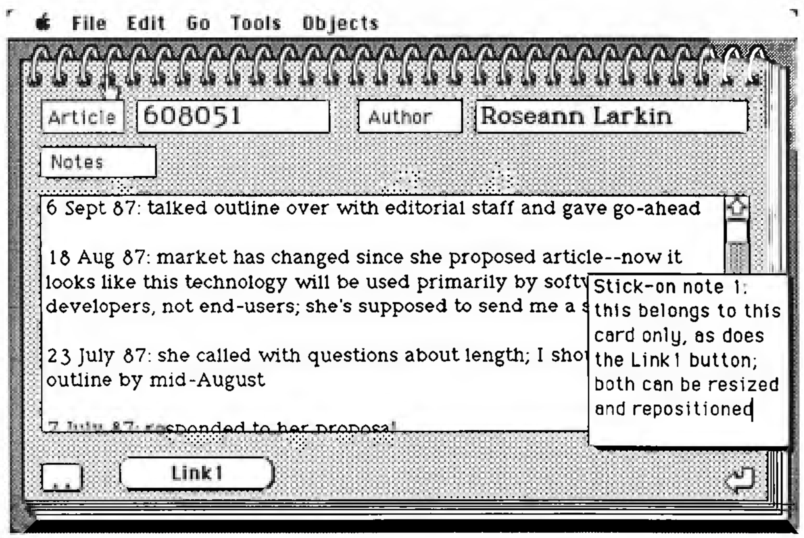


Fig 1 The Home stack. Apple supplies HyperCard with 20 stacks, any of which you can jump to by clicking on its icon. Other cards in the Home stack contain global information, like your user level and the different search paths it should use when looking for files



Article 608051

Author Roseann Larkin

Notes

6 Sept 87: talked outline over with editorial staff and gave go-ahead

18 Aug 87: market has changed since she proposed article--now it looks like this technology will be used primarily by soft
developers, not end-users; she's supposed to send me a

23 July 87: she called with questions about length; I sho
outline by mid-August

7 July 87: responded to her proposal

Stick-on note 1: this belongs to this card only, as does the Link1 button; both can be resized and repositioned

Fig 2 The Project s stack. This stack was created by the author to keep track of ongoing projects within APC. *The two icons in the bottom corners and the four text fields belong to the background and are shared by all the cards in the stack. The 'Link1' button and 'stick-on note' field belong to this card only. See Fig 3 for an exploded view of this card's components*

The first level is Browsing, which lets you look through stacks created by others. It's very simple, and you can't do anything harmful to the stack. In both this level and the next, the cursor is a small pointing hand called the browse tool, and you can browse through the cards by clicking on icons and by using the arrow keys and certain command keys.

At this and all other levels, you can also interact with HyperCard through the Message Box. When you type commands into the Message Box, HyperCard acts on them; the messages can be anything from go to last card to find 'Sydney' in field 'City' to go to stack 'Projects'.

The second level, Typing, lets you add new cards and change the text in a card's fields. One of the many simple stacks that Apple includes with HyperCard is an Address stack containing name-and-address cards. With a single menu selection, you can create a new card. Then, by clicking in the card's fields and typing, you can create a new entry. By selecting the 'Find . . .' menu item, typing in what you want to search for, and pressing Return, you can search for any name and address. If you click on the small telephone icon by the phone number on the card, HyperCard will even dial the number for you.

Things get interesting in the remaining four levels (Painting, Authoring, Scripting, and what I call Metascripting) so much so that I'm devoting entire sections to them below. But first, let's look more closely at the components of a card.

Card layers

Cards are more complicated than they appear. Pictures (MacPaint-like images), buttons, and fields may belong to both a shared background and an individual card. Items that belong to the background appear on and are shared by every card using that background. Those that belong to the card itself are on that card only.

Take, for example, a simplified version of the Projects stack that I created to keep track of manuscripts coming in to *APC* (see Fig 2). The article number, author, and notes fields are background fields, as are the address-card and return-arrow buttons on the bottom row, so they will be present on each

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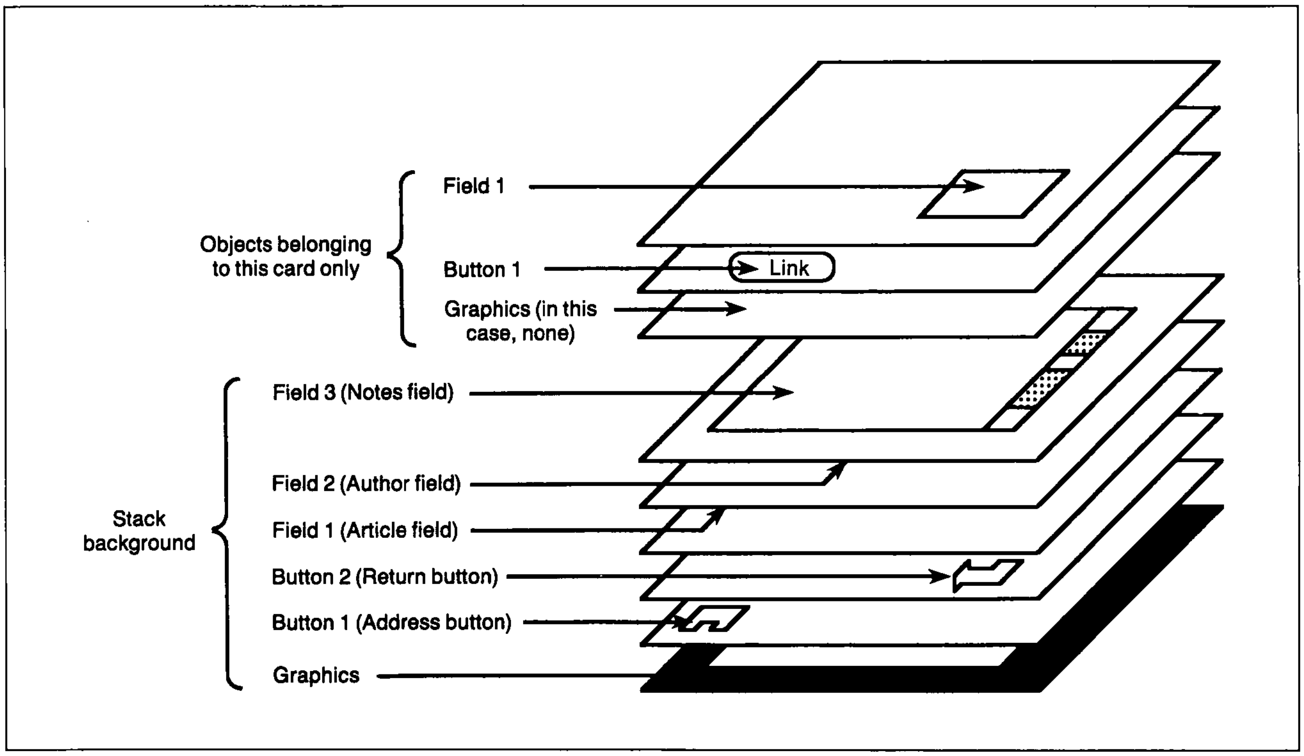

Fig 3 Card layers. This exploded view shows the logical units that combine to make a card. All background items are 'under' their foreground counterparts and can be occluded by them (as is the case with the card's 'stick-on note' field covering the background 'Notes' scrolling field

card in this stack. (The Projects stack uses only one background, but stacks can contain cards that use different backgrounds.) On the other hand, the 'Link1' button and the 'stick-on note' field belong to this card only.

Fig 3 shows the different layers of the Projects stack. As you can see, each button and field is in a sublayer that has its own identification number — the button or field closest to the picture is always numbered 1, and buttons or fields closer to the top layer are numbered 2, 3, 4, and so on. Depending on their properties, items that are in higher layers will cover lower ones, and they will also intercept mouse movements and clicks.

Painting

Bill Atkinson was certainly not going to create a painting subsystem within HyperCard without making some improvements to the tool set in his original MacPaint. HyperCard makes a palette of painting tools available when your user level is Painting or higher. Fig 4 shows the Tools and Patterns menus, both of which you can access from the menu bar or 'tear off' and place conveniently on the screen (this new feature is especially useful on the Mac II or any Mac with a large display).

The Painting subsystem contains a number of new tools (like the regular polygon tool in the bottom centre of the Tools menu) and new capabilities (like the ability to rotate and flip lasso-selected shapes). There are too many to mention here, but they are useful and deserve study.

Because the visible card image results from multiple layers of items, Atkinson had to create a more complex bit map that stores images using multiple bits per pixel. A pixel is no longer limited to the values of black and white; it can now also be transparent. So, for example, you can hide background details by painting over them with white in the card layer, and you can reveal the image underneath by erasing what looks like a blank (white) area.

Authoring

At the Authoring level, you can interact with buttons and fields in several ways. First, you can cause a button to point to any other card in any stack accessible from your Macintosh (even stacks on remote file servers); Apple calls this linking cards. Second, you can re-use predefined buttons that are supplied with HyperCard. Third, you can manipulate buttons and fields by clicking on them with the button and field tools, respectively (available from the Tools menu, shown in Fig 4).

As an example of using a button to link your current card to another one, let's say that I need to get to my to-do list whenever I talk to, for instance, Roseann Larkin. I can easily create a button for her Projects card as follows:

- I go to her card and select 'New Button' from the Objects menu. HyperCard gives me a highlighted rounded-rectangle button named 'New Button'.
- I then double-click on this button, which gets me its Button Info box. I rename the button 'To Do' (see Fig 5a).
- When I click on the LinkTo button, HyperCard returns me to the current card and gives me a dialog box that 'floats' above whatever card image I display. I can then go back to my Home stack, then to my To-Do card (which is actually card 33 of the stack Datebook). By then, my screen looks like Fig 5b.
- I finish by clicking the 'This Card' button. This takes me back to my Projects card and causes HyperCard to link my To-Do button to the To-Do card in the Datebook stack. On a 2Mbyte Mac Plus with a SCSI hard disk drive, this entire process takes about 16 seconds.

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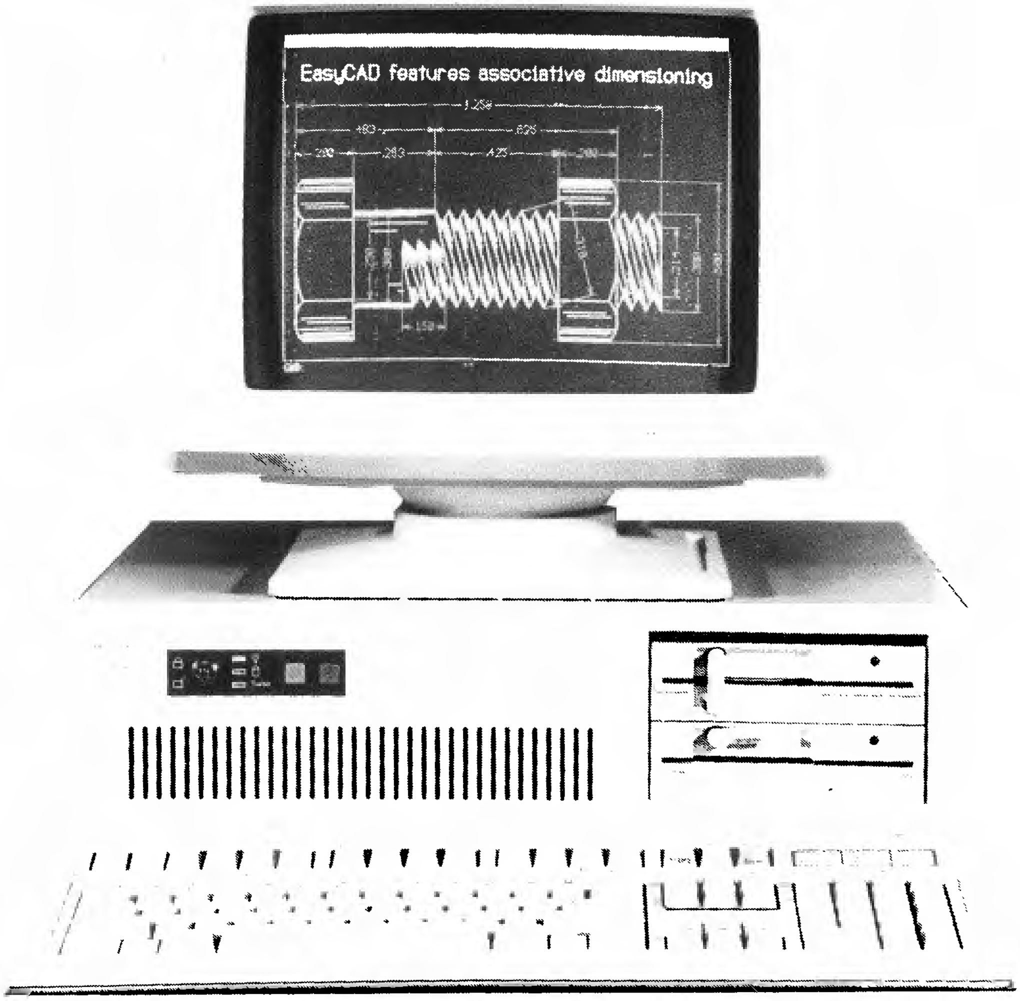

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Sextant 266

Now, whenever I click on this button, I go to the To-Do card in my Datebook stack (this takes about three seconds). If I had chosen the 'This Stack' button above, I would have been linked to whatever card is card 1 of the Datebook stack at the time the button is clicked (not what I wanted here, but useful in other circumstances).

One of the most interesting button options is the transparent style of the button. You can place a transparent, rectangular button of any size on the screen. Since it is invisible, you can see through it to whatever graphics, buttons, and fields are underneath. You can do some amazing things with this. For example, Apple supplies a Clip Art stack with invisible buttons over various sub-areas. The result is that you can click on a hat in the image, for example, and the invisible button takes you to the next image with a hat in it. There's no magic here, though; someone manually linked each button to the next appropriate image.

You can do more sophisticated things by cutting and pasting buttons from the 'Button Ideas' stack, which contains several screens' worth of useful buttons. (HyperCard includes 20 example stacks that either do something useful or give you resources you can use, like this stack of buttons.) Some buttons take you to the next, previous, first, last, or any random card in the stack. Others have names like 'Dial', 'Sort' and 'Show Cards'.

Finally, you can use the button and field tools to manipulate buttons and fields. Once you have selected a button or tool (ie, it is enclosed in the 'marching ants' animated outline), you an move it by dragging it from its middle or resize it by dragging it from any corner. If you call up its dialog box (by double-clicking on it or selecting the 'Button Info . . .' or 'Field Info . . .' menu items), you can then access a number of properties, including its visual appearance and its script (described below).

Scripting

Scripting is the level at which you can examine and change the small programs, called scripts, that execute when you click a button. These scripts are written in an English-like language, HyperTalk, that is simple, elegant, and very powerful.

Take, for example, the 'Dial' button on cards in the Address stack. It looks for a valid phone number, first in a highlighted section of text, then in the Message Box; it then jumps to the Phone stack, dials the number, and returns. The script that does this is:

```
on mouseUp
  get the selection
  if it is empty then ask "Dial¬
    what number?"
  if it is not empty then
    push this card
    visual effect zoom open
    go to stack "Phone"
    dial it
    pop card
  end if
end mouseUp
```

The script is largely self-explanatory. The 'on mouseUp...end mouseUp' pair specifies when the enclosed commands are to be executed; the 'mouseUp' event occurs when you release an already-pressed-down mouse button. The variable 'it' contains the result, if any, of the previous command. The 'push' command saves your place before you go to the new stack, and 'pop card' returns you. The 'visual effect' command is a nice touch that lets you specify one of 17 visual transitions from one card to the next.

Inside HyperTalk

HyperTalk scripts are event-orientated: they execute when a certain even occurs. Some events are generated internally (like 'idle', which is generated when nothing else is happening). Others are generated when the user presses a key ('tabKey'), manipulates the mouse ('mouseDown'), or chooses a menu entry ('newField'). In addition, scrips themselves can generate events ('doMenu' '"Delete Card" ').

Actually, these 'events' ripple through HyperCard as messages. When a message is generated somewhere within HyperCard, it searches through the scripts of selected objects and stops when it finds a region of code (called a message handler) that it satisfies. There are five kinds of objects in HyperCard — stacks, backgrounds, cards, buttons, and fields — and each of them can have its own script.

If an object gets a message it doesn't understand, it passes the message to another object according to the hierarchy of HyperCard objects. Ignoring the shaded boxes for the moment, Fig 6 shows the order in which a message searches for a message handler that it will satisfy. In the most common case of a mouse event, for example, its message searches first the button or field it was over when it occurred, then the card containing the button or field, then the card's background, the card's stack, the Home stack, and, finally, HyperCard itself. If none of those recognises the message, HyperCard issues a dialog box that says 'Can't understand' <message name>.

These elements make HyperTalk a simple object-oriented language (OOL). It operates on different kinds of objects that interact by sending each other messages. The HyperTalk message handlers are equivalent to an OOL's methods, and the inheritance path makes it possible for certain objects to 'inherit' message handlers from another object or to override them with ones of their own. Even though HyperTalk lacks the ability to create new classes and its object hierarchy is not a pure OOL hierarchy, HyperTalk will do more to introduce thousands of people to object-oriented programming than previous OOLs have.

HyperTalk is full of commands (46 of them), control structures (six), functions (49), properties (58), constants (11), and operators (21); all were carefully chosen to work synergistically with one another. It includes procedures and functions with named parameters and local and global variables. All variables are stored as strings and interpreted as strings or numbers according to context; all named things are stored in a case-insensitive way. Variables default to being local to the message handler in which they occur; to be global, they have to be declared as

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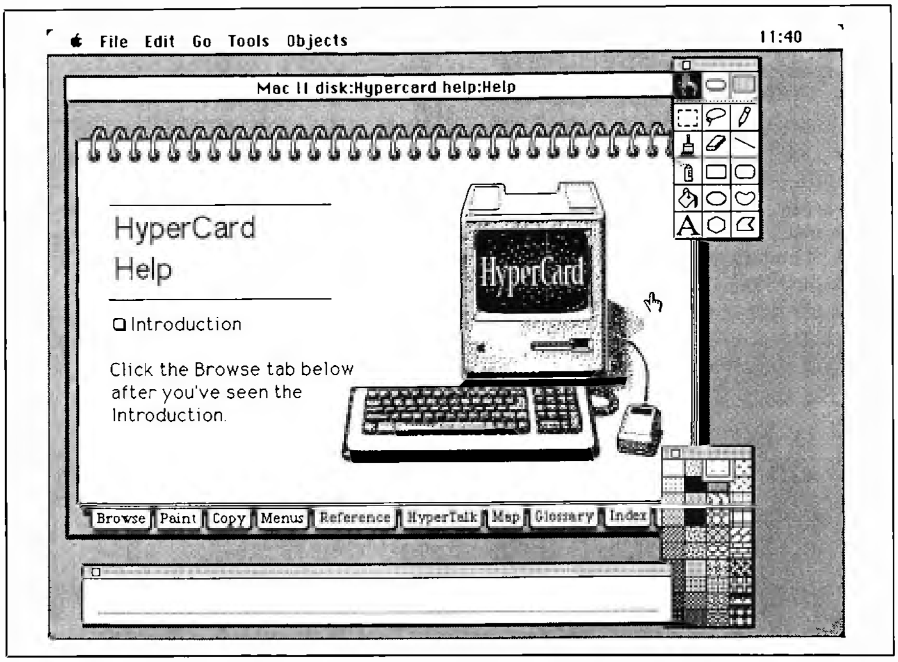


HyperCard Help

❑ Introduction

Click the Browse tab below after you've seen the Introduction.

Fig 4 HyperCard on a big-screen Macintosh. If you have a display screen that is larger than a HyperCard card (this image comes from a Mac II), the card appears in a fixed-size window, and you can use the extra space to show the Message Box (bottom centre), the Tools menu (top right), and the Patterns Menu (bottom right). The last two items, new to the Macintosh, are 'tear-off menus' that can be called from the menu bar, as usual, or from an arbitrary position on the screen. Note that these three windows and the HyperCard window 'float' above the background and can overlap

such in each handler that wants to use them.

So far, two books document the HyperTalk language. The first is *The Complete HyperCard Handbook*, by Danny Goodman (published by Bantam Computer Books, imported by Transworld Publishers, and should be available at major bookshops for around $65 by the time you read this). It is huge — 720 pages — and contains both tutorial and reference information about HyperTalk and other aspects of HyperCard. Apple's *HyperCard Script Language Guide* is currently available only in the US, from APDA (Apple Programmer's and Developer's Association), 290 Southwest 43rd Street, Renton, WA 98055, (206) 251 6548, for $US19.95. It gives more rigorous definitions for HyperTalk but contains little tutorial material.

Metascripting

There's no official name for this hidden, sixth way of using HyperCard, so I'm called it metascripting because of the way it extends scripting (or, in other words, programming). Metascripting enables a Macintosh programmer to add new commands to HyperTalk.

Here's how you do it: you write the appropriate code in C, Pascal, or assembly language, compile it without a header as a code resource of type XCMD (for message handlers) or XFCN (for functions), and paste it into the resource fork of your stack, the Home stack, the System file, or HyperCard itself. Then, when you use that resource's name in a HyperTalk script, HyperCard executes the XCMD or XFCN resource with the same name.

Through such extensions, many people can use HyperCard, especially those with no technical background, to organise and manipulate any data they find useful: sound, voice, animation, music-synthesiser data — whatever. Sources at Apple have also indicated that the company will eventually make it possible for Mac software developers to develop nonstack applications that can read and write stacks.

Technical details

Bill Atkinson says that he and his colleagues worked hard to develop special algorithms to speed up the searching of cards, reduce the stored size of graphic images while maintaining quick storage and retrieval times, and speed the printing of graphic images to the LaserWriter printer. Though Apple wants to keep these algorithms secret, Atkinson and Dan Winkler (the designer of HyperTalk) made a few comments about the graphics and search algorithms.

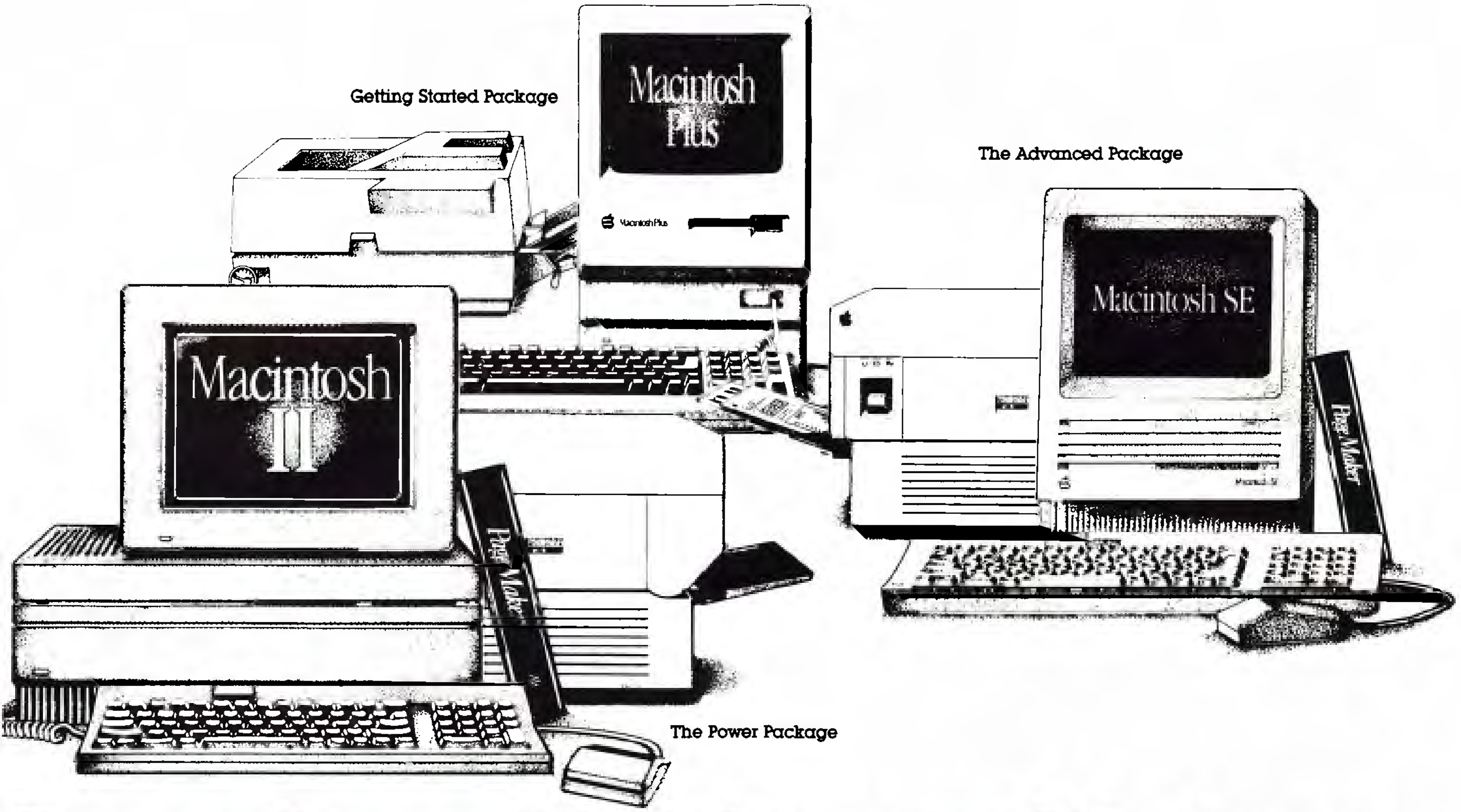
The graphics compression routine uses 'a family of encoding techniques' on each line of the image and keeps the one that encodes that line the most compactly — that is, different lines may be encoded using different methods. Atkinson also hinted that the compression methods take into account adjacent pixels in the preceding and following lines, not just (as is usually the case) the adjacent pixels on the same line. He also said that these methods have resulted in up to a 30x-size compression of graphic images.

HyperCard always treats stacks as disk-based files. Although it uses extra memory to cache recently manipulated cards, it doesn't depend on having them in memory for its speed. HyperCard maintains a string of 'hint bits' (ie, a hashed value) for each card and keeps that data in memory. When it searches for a given string, it compares the hint-bit data of the target word with the hint-bit data for all the cards, retrieving and searching the full text of only those cards that might contain the target word.

Performance

I spent several hours creating some very large stacks (775k to 2.78Mbytes) and manipulating them on a 2Mbyte Mac Plus with a Data Frame XP20 SCSI hard disk drive. Since I used the first shipping version of HyperCard, version 1.0.1, I believe I can legitimately comment on its performance. I eventually settled on a stack that, in its most compact form, contained 792k of information. This stack contained 973 electronic messages of various lengths (using a scrolling-text background field) and containing 'real-world' data, stored one message per card.

In this stack, search times for a target word contained only in the last few messages (cards 971 to 973) usually ranged from under one second to about three and a half seconds, with most searches being in the one to two-second range. However, in one case, HyperCard took 23 to 30 seconds in successive attempts to find one target word. According to Dan Winkler of Apple, this was probably a worst-case example in which the target word encoded to the same value as another



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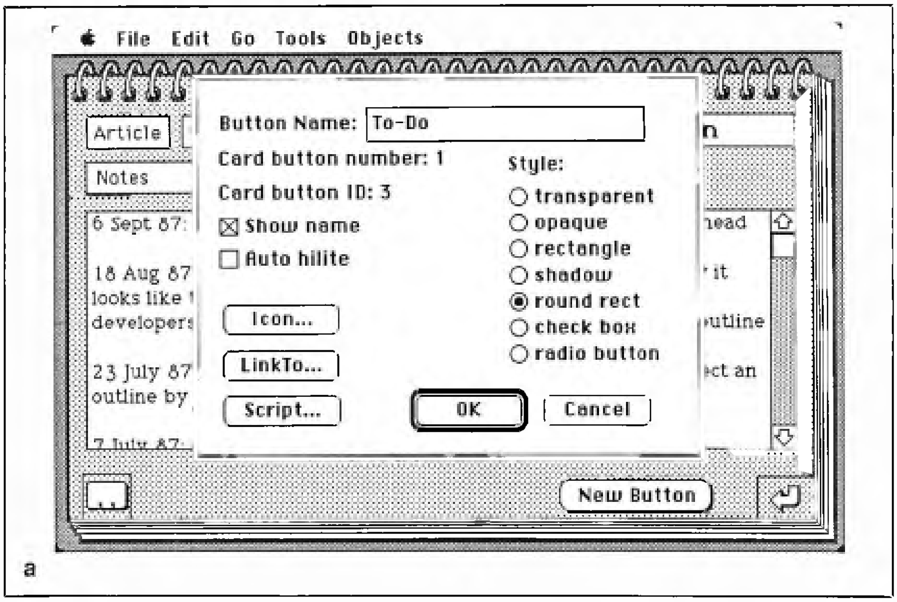
commonly used word, thus forcing a large number of card retrievals from disk.

You can also search for an arbitrary character string, but this is much slower. For example, HyperCard found a word in one of the last cards in 3.5 seconds, but when asked to find the word as a string of characters, it took 28 seconds (though this is still a very reasonable time for searching a 792k file).

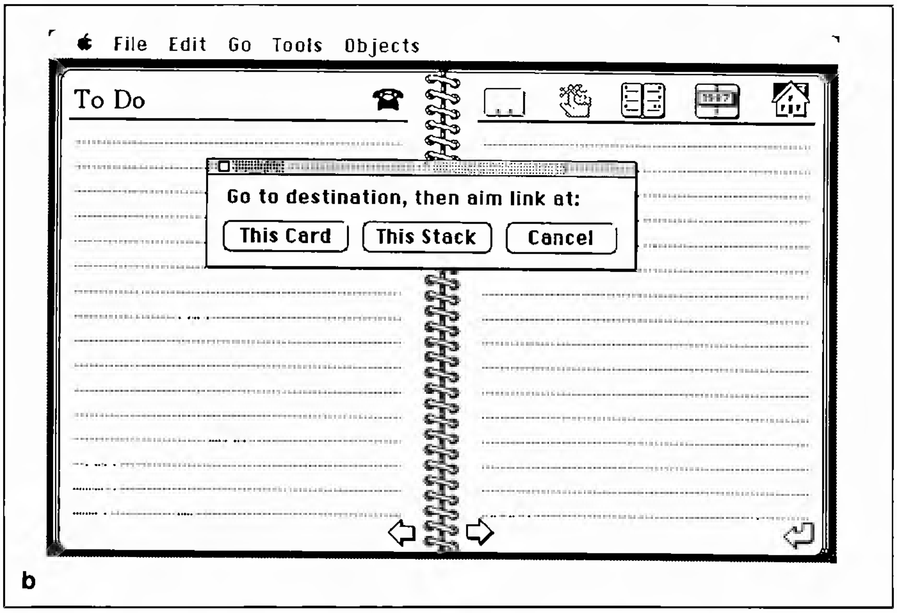
Also, after creating a 2.78Mbyte address stack, HyperCard repeatedly crashed when I tried to compact it. Dan Winkler acknowledged that Bill Atkinson has found and corrected a bug in version 1.0.1 that causes problems 'only with very large stacks.' Later versions (which should be shipping by the time you read this) will have that bug fixed.

Although HyperCard will run on a 1Mbyte Mac Plus with two 800k floppy disk drives, a hard disk drive and extra memory are almost essential. HyperCard and the Home stack (the only stack required to be present) total 427k, and the excellent tutorial Help stacks (three of them) total 738k. You need the extra memory so you can keep HyperCard and your other applications constantly available through the use of either Switcher or MultiFinder. With enough memory and hard disk space, HyperCard is a joy to use.



Button Name: To-Do
Card button number: 1
Card button ID: 3
☒ Show name
☐ Auto hilite

Style:
○ transparent
○ opaque
○ rectangle
○ shadow
● round rect
○ check box
○ radio button



Go to destination, then aim link at:

Fig 5 Linking a new button to a destination. Every button can call up a 'button info' dialog box ***(a)*** *that allows you to modify the button's appearance and behaviour. By clicking on the 'LinkTo' button, then moving to the desired destination and clicking the 'This Card' button* ***(b)****, you can cause the new button (which will be renamed 'To Do') to jump HyperCard to the destination when it is selected*

Limitations

HyperCard will meet the needs of many people, but it is not the ultimate data-manipulation program. Database-management applications, for example, need not fear that HyperCard will make them obsolete. HyperCard knows only how to search for a single word or a character string; it ignores the case of words in all its searches, it can't search for strings that have wild-card characters in them, nor can it search for a combination of items (though it shouldn't be too hard to write a script to do that). HyperCard also has no built-in command to do a search-and-replace operation.

Another imperfection is that, unlike most Mac applications, HyperCard has modes. For example, when you are in button mode (using the button tool from the Tools menu), you can't move fields or type text into them. More annoyingly, if you're in foreground mode, you have to explicitly switch to background mode to ensure that new buttons and fields will belong to the background instead of to the current card. Atkinson acknowledged HyperCard's problem with modes, but he said that it has no mode problems at the Browsing and Typing levels that many novices will confine themselves to.

Another interesting limitation is that HyperCard abandons the window metaphor and takes over the entire screen (unless you're using a Macintosh with a large screen). Sometimes I found myself feeling somewhat claustophobic and wanting to see more than one card at a time (which would be easier if cards were displayed through windows). Also, cutting and pasting multiple fields or buttons can become tedious because you can only cut and paste one at a time.

Granted, HyperCard isn't perfect yet — but it's far closer to perfection than the original 128k Macintoshes were when they first came out. One can quibble about minor flaws in HyperCard, but overall, it's already a very useful, fast, and elegant product, and Bill Atkinson has promised enhancements — including multi-coloured cards — sometime in the future.

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Final words

Years ago, new automated dialling circuitry in the telephone system allowed the expansion of phone service past the limit imposed by the finite number of human operators — in effect, you became your own operator. HyperCard has a similar potential: to allow the creation of a far larger number of useful programs than is possible from the work of a finite number of professional software developers. We will become our own programmers, and we will be able to create new programs and modify existing ones to meet our needs.

END

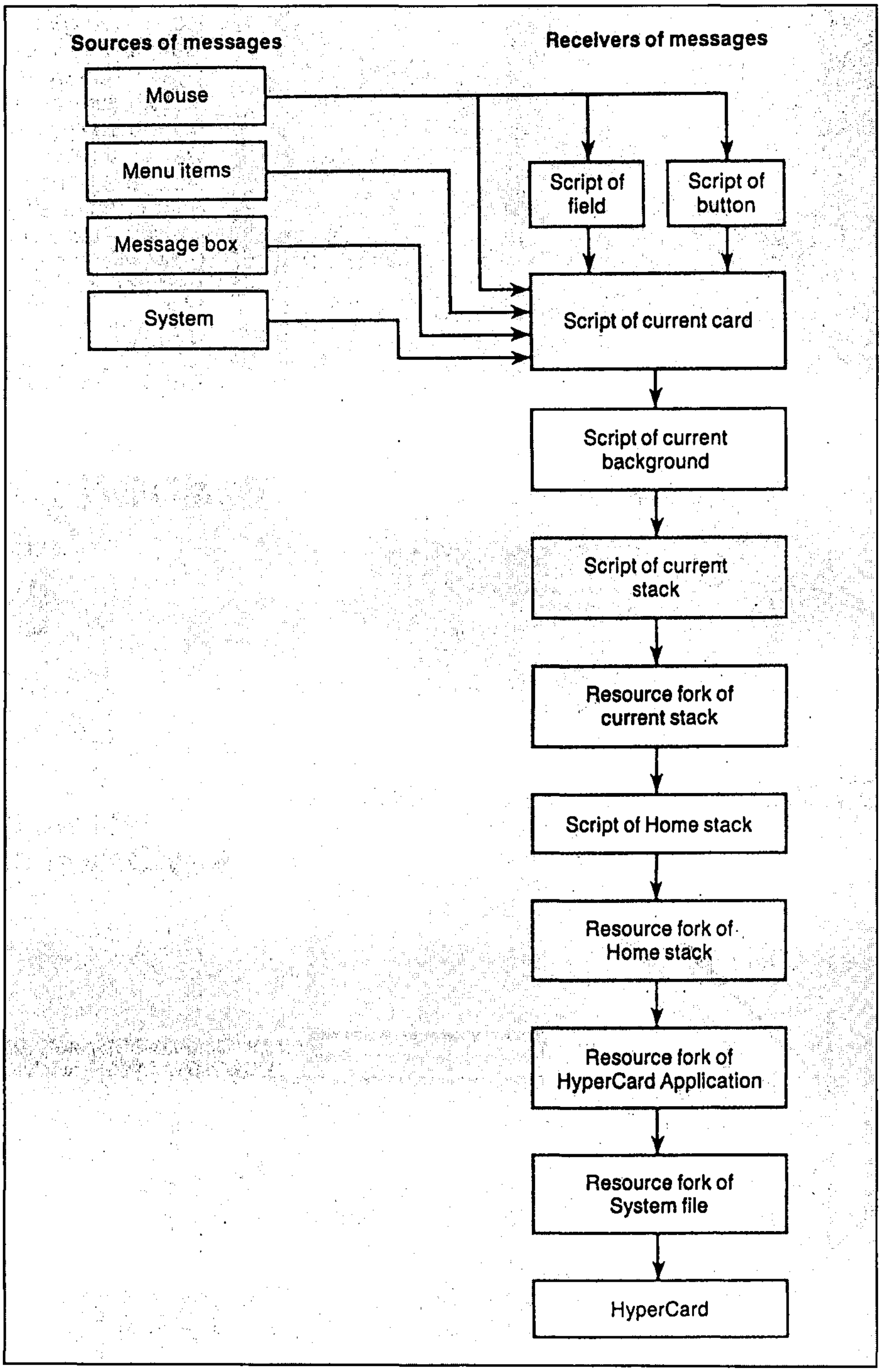
Sources of messages
Receivers of messages
Mouse
Menu items
Message box
System
Script of field
Script of button
Script of current card
Script of current background
Script of current stack
Resource fork of current stack
Script of Home stack
Resource fork of Home stack
Resource fork of HyperCard Application
Resource fork of System file
HyperCard

Fig 6 Inheritance hierarchy within HyperCard. This figure shows the order in which messages search for a message handler that they can satisfy. Shaded fields denote the resource forks of certain files, where custom-defined commands and functions may reside

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- BILL OF MATERIALS
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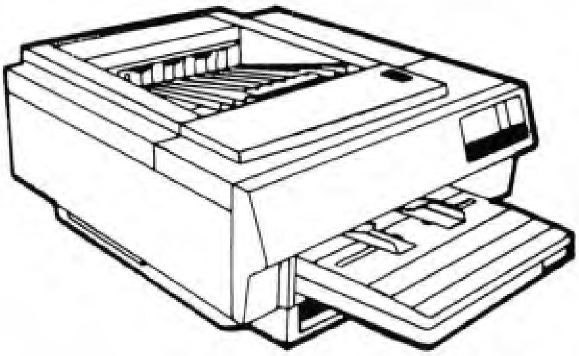

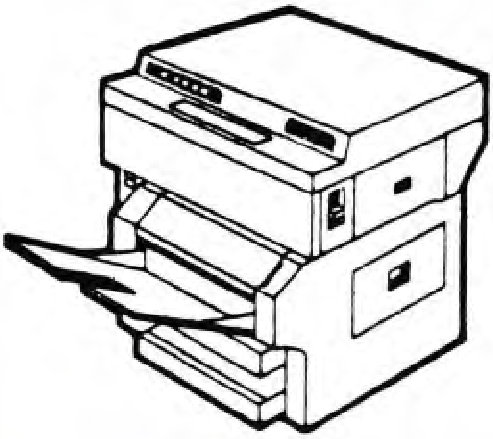

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386 operating systems

Next year sees Microsoft's OS/2 enter the market, and this is being heralded as the best thing to happen in the world of 386 system software. Some people can't wait, however, so Nick Walker presents a review of four products that utilise some of the 386's more advanced features.

So you have a shiny new 80386-based IBM compatible on your desk. What are you going to do with it? In 90 per cent of cases the answer seems to be run existing MS-DOS applications. True, they'll run lightning fast, but doesn't it seem a waste to use this wonderful 32-bit multi-tasking processor running single 16-bit applications in a restricted 640k of memory? According to the sales literature, the 80386 is capable of multi-tasking while addressing 4 Gigabytes (4000Mbytes) of memory and yet still retains compatibility with existing MS-DOS software.

The problem is lack of software. There are no applications that use the 80386 to its full advantage, and until some 286 and 386 operating system standards are set, there won't be any. The operating system we are supposedly all waiting for is OS/2 — the 80286-based operating system from Microsoft. With luck, initial shipments of OS/2 will begin early next year but I doubt it will become truly useful until 1989.

For those who can't wait or have doubts about OS/2, there is some system software that lets you exploit the power of this processor and it's available *now.*

In this review, I'll examine four products that make use of the 386's more advanced features. Two of the products are full-blown operating systems: PC-MOS from The Software Link (TSL) and Concurrent DOS 386 from Digital Research.

The other two products co-exist with MS-DOS 2.11 and enhance its functions — Windows 386 from Microsoft and DESQview from Quarterdeck.

Concurrent DOS 386

Digital Research has offered an alternative to MS-DOS from the IBM PC and its compatibles ever since the PC was launched. The 386 is the latest addition to the Concurrent DOS family — a collection of operating systems that offers a high degree of compatibility with MS-DOS applications and also true multi-user and multi-tasking facilities. To be compatible with Digital Research's previous operating systems, Concurrent DOS 386 also offers data file compatibility with CP/M 86. Concurrent DOS 386 uses the advanced facilities of the 80386 to provide a more secure and more powerful variant of standard Concurrent DOS.

Overview

Concurrent DOS 386 is one of the true operating systems of the products reviewed. It does not totally replace MS-DOS but sits alongside it to be called upon when required. Unlike Windows 386 and DESQview, which use the existing MS-DOS to their advantage, Concurrent DOS 386 makes no use of the MS-DOS system or system files once running. What separates Concurrent DOS 386 from previous versions is the way in which it uses the 386 processor — the processor is constantly switched into virtual 8086 mode. In this mode, it behaves like lots of separate 8086 processors running simultaneously, each in its own memory area.

Concurrent DOS 386 is both a multi-tasking and multi-user system capable of supporting up to ten users from a single machine. Each user on the system is assigned to one of the virtual 8086 processors and can run up to four multi-tasking applications, provided they can generate the right command from their terminals. Using hardware rather than software partitions of the users and tasks ensures that all the users are secure from each

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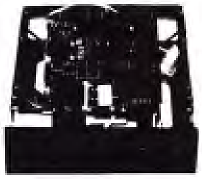

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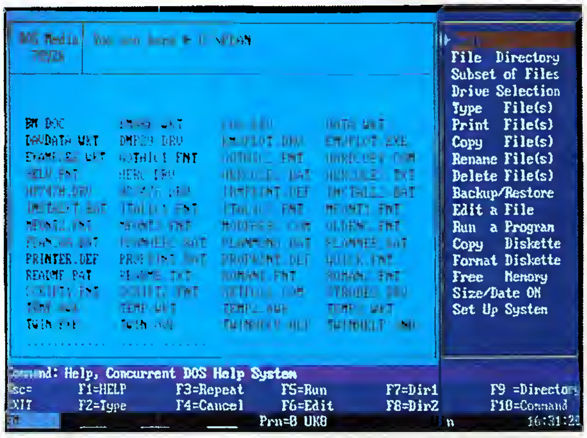
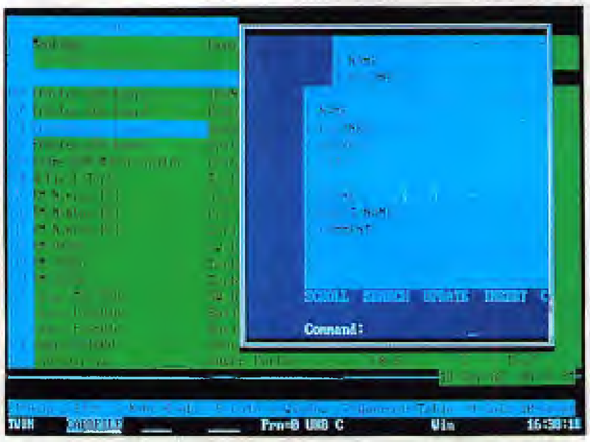


The file manager included with Concurrent DOS 386 offers features similar to Xtree. New applications can be configured, disks formatted, directories searched and programs launched



A simple windowing system is provided with Concurrent DOS 386. The windows are limited to text-based applications and cannot be re-sized when an application is running

other and in theory, any user could have a system crash and recover without disturbing anyone else.

As the majority of MS-DOS applications are not written to be used in the multi-user sense, a number of Concurrent DOS specific applications have been developed (multi-user, multi-access databases, for example). Although Concurrent DOS 386 uses one of the features of the 80386 chip, it sets no standards for running 32-bit native mode software. Using this operating system is, therefore, strictly for running the various varieties of 16-bit software.

Installation

Concurrent DOS 386 has the easiest installation procedure of any operating system I have installed. Booting the system with disk one of the five floppy disks supplied takes you through a menu-driven installation program that copies all the files and determines which facilities are available on the system. Once installed you can choose which operating system, MS-DOS or Concurrent DOS 386, you would like the system to boot up with. If you want the system to start up in Concurrent, an extra command is added to your existing 'AUTOEXEC.BAT' start-up file.

You need a minimum of 512k of RAM and two floppy disk drives, although a hard disk is obviously preferable. If the system has more than 640k of RAM, the virtual 8086 mode of the processor means the extra memory is automatically used when required — there is no need for a page memory scheme such as LIM (Lotus, Intel, Microsoft standard). The 386 uses the entire memory space in an ordinary linear fashion. The speed benefit of any extra RAM is highlighted when using the system multi-user or multi-tasking.

The fact that Concurrent DOS 386 doesn't interfere with MS-DOS means that you can quit Concurrent at any time and return to MS-DOS. After installation the first thing to do is run the 'SETUP' program and configure the system. From here you can inform the system of up to five printers connected to both parallel and serial ports and two other users using terminals connected to serial ports.

In use

Concurrent DOS 386's command structure is very similar to MS-DOS. Commands can be executed directly from the Concurrent DOS A> prompt in the MS-DOS fashion; however, a lot of the commands can also be issued from a number of menu programs. The majority of standard MS-DOS commands are supported.

An Xtree-like program can be invoked by pressing the F2 function key or typing FM at the command line. The screen is divided into three: a main panel listing files, a command panel of commonly used operating system commands, and a prompt panel at the bottom which also lists the current function key designations. From this program, you can perform most of the operations normally issued at the MS-DOS prompt. All the usual features of a file manager program are there including launching programs, specifying wildcards, tagging files and directory management. Its more unusual features include the manipulation of CP/M media and an internal back-up routine.

The control key in combination with the 1 to 4 numeric keys allows you to switch between multi-tasking applications. The first time the command is issued, a new version of the operating system is launched for that task.

Initially, the four multi-tasking applications take over the whole screen when they are invoked. Concurrent DOS 386 has a system of windows which, in theory, allows you to run applications within windows. However, when I attempted this, I ran into many problems. The first problem was the failure of any program that attempted to use EGA graphics. Digital Research assures me that Concurrent DOS 386 should be able to multi-task one EGA application and have others suspended. A window command or window menu program allows you to display all four tasks on the screen simultaneously. Manipulating the window while the applications are running causes screen conflicts, so Digital Research suggests that you first set up the windows you require before running the application within them.

Windows are only capable of handling well-behaved text applications — CGA or EGA graphics need full screen. All this is extremely limiting and seems to defeat the object of windows. My recommendation is to stay with the default of each task occupying its own screen.

Multi-tasking and multi-user systems have to solve the problems of conflicts over access of a device. For example, two tasks and two users may start to print at the same time and it's up to the operating system to sort it all out. Concurrent DOS will support up to five printers and happily have all five print-

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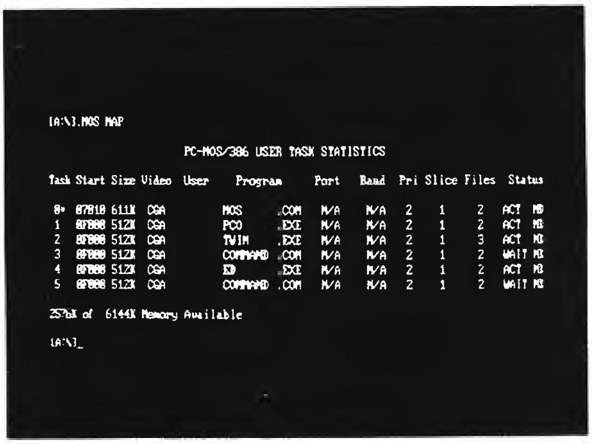

```
[A:\].MOS MAP

                    PC-MOS/386 USER TASK STATISTICS

Task Start Size Video  User    Program     Port   Baud  Pri Slice Files  Status

 0*  07818 611K  CGA          MOS     .COM  N/A    N/A   2    1     2   ACT  NB
 1   0F000 512K  CGA          PCO     .EXE  N/A    N/A   2    1     2   ACT  NB
 2   0F000 512K  CGA          TWIN    .EXE  N/A    N/A   2    1     3   ACT  NB
 3   0F000 512K  CGA          COMMAND .COM  N/A    N/A   2    1     2   WAIT NB
 4   0F000 512K  CGA          ED      .EXE  N/A    N/A   2    1     2   ACT  NB
 5   0F000 512K  CGA          COMMAND .COM  N/A    N/A   2    1     2   WAIT NB

2576K of  6144K Memory Available

[A:\]_
```

PC-MOS offers a high degree of control over its multi-user and multi-tasking features. The MOS MAP command, shown here, gives a list of all tasks active, which users they belong to, priorities, and memory allocation

ing concurrently. All printing runs via a printer spooler file containing all the text awaiting printing, even if two users want to access the printer at the same time. A printer manager program allows the user of the main screen to control this queue of files to be printed.

There are a number of other features which improve upon the facilities of MS-DOS. These include the three commands EDITMENU, RUNMENU and COPYMENU which allow you to create your own menus to control the system. A macro definition facility allows you to change the commands assigned to the ten function keys and numeric keypad keys. In combination with Ctrl, Alt and Shift, 50 macros of up to 20 characters each can be assigned. Six batch files called STARTUP1.BAT to STARTUP6.BAT replace the single AUTOEXEC.BAT of MS-DOS and are run upon start-up. The first four correspond to the four tasks of the main system user and the last two set up the serial terminals.

I was pleasantly surprised by how compatible Concurrent DOS 386 was with existing MS-DOS applications. The two main exceptions are memory resident and badly-behaved programs that insist on using an EGA screen. Digital Research claims that version 2.0 of Concurrent DOS will be able to support both these and will even run the extremely badly-behaved SideKick from Borland.

In the main, however, Concurrent DOS 386 ran 95 per cent of the software I tried on it, including PC Write, PC Outline, GEM, Lotus 1-2-3, WordStar Release 4.0 and Microsoft Flight Simulator version 2.0. Microsoft Word ran smoothly until it came to the spelling checker which loads memory-resident. CP/M compatibility is limited to data file compatibility — the hard disk utility creates a partition that conforms to the CP/M standards but this does involve reformatting the hard disk and starting from scratch. Memory schemes such as EMS run perfectly under Concurrent DOS, even when two multi-tasking applications are using it at the same time. I felt sure it would crash.

Very few applications can be made to run on terminals attached to the system, as these have to be strictly text based and use no screen addressing. Even applications requiring the ANSI.SYS screen addressing system will fail when used from a terminal. Release 2 of Concurrent DOS 386 is claimed to support IBM emulation terminals which means that additional users will be able to run straight MS-DOS applications and use multi-tasking.

Concurrent DOS uses the simplest kind of multi-tasking, with each task given 1/60th of a second. The processor just cycles between them in a round-robin fashion: there are no priorities to assign to tasks and the only possible control is to suspend a task. The system seemed quite secure — on a number of occasions, a single task crashed in a way that would normally bring the whole system down but, switching to another task, suspending the crashed one and then relaunching it, rescued the situation.

I didn't have the facilities to set-up a true multi-user system so I was unable to test the system in that sense. The version I used was a three-user version, and a ten-user version is also available. Looking at the manual gives the impression that there is very little security in the usual multi-user sense. There is no log-in procedure and no user privilege levels — only a password which can be assigned to files or directories.

Two 'applications' are included with Concurrent DOS 386: a text editor to replace and surpass MS-DOS's EDLIN (not difficult) and a simple card file solely for storing names, addresses and phone numbers. Both are adequate for their purpose but are nothing spectacular.

Documentation & prices

The manual included with Concurrent DOS 386 consists of two separate volumes: the *User's Guide* and the *Reference Guide*. Both are bad but the *User's Guide* is truly awful, leaving me more confused than I was before I consulted it. Digital Research should watch a new user installing and using the system and then re-order and re-index the entire manual. My advice is throw the *User's Guide* away and use the online help facility and *Reference Guide*.

Concurrent DOS 386 (available from Micro Australia on (02)736 3299), costs $735 for the three-user version, and a ten-user system costs $1005.

PC-MOS/386

PC-MOS/386 is The Software Link's (TSL) first attempt at a complete operating system and it is compatible with a large number of existing MS-DOS applications. In addition, PC-MOS offers a multi-tasking, multi-user environment and, most surprisingly of all, a standard of its own for the development of native 32-bit 80386 software. It is the most ambitious of the products reviewed here.

Overview

PC-MOS can totally replace MS-DOS. I believe there is no way both operating systems can exist on the same machine, as PC-MOS actually replaces the system files of MS-DOS with its own of the same name. It uses the 80386 processor in a very ingenious way because it not only uses the virtual 8086 mode, but also switches into native 386 mode to run 32-bit software.

PC-MOS is capable of supporting up to 25 users from a single machine. It distinguishes no difference between a task and a user. The main system user must, however, create a task that activates a user's terminal on a serial port. A total of 99 tasks is available providing you have the memory to run them. TSL applied the limit of 25 users just to maintain a reasonable performance.

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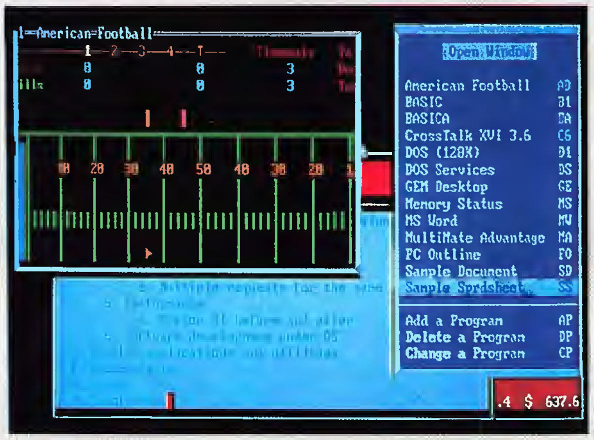
DESQview 2

DESQview is an application integrator, which means that it is a single-user, multi-tasking environment for existing MS-DOS applications. DESQview works on any ordinary PC-compatible but benefits from running under an 80386-based machine. Before covering the advantages of using DESQview on an 80386 machine, I will briefly address the features of DESQview that all users can access (for a complete review of DESQview see *APC* September issue).

DESQview divides processor time between all the applications running on a variable time-slice basis. A basic windowing system means that it is possible for the user to watch all the applications running and act accordingly. One feature unique to DESQview is its use of virtual memory, which means that you can have more programs running than will fit in your computer's memory. When there is no more RAM available of a program, DESQview swaps a program you are not using to the PC's hard disk.

When using an 80386 processor, DESQview automatically invokes the virtual 8086 mode of this processor. This has a number of benefits. Firstly, all the available memory is used before DESQview starts to use the hard disk for program swapping. However, the best aspect of using DESQview with a 386 machine is the autonomy it gives to each multi-tasking program. The separate video memory assigned to each program means that practically everything will run in a window without affecting any other windows — including CGA graphics programs which are normally suspended; the only exception to this being EGA graphics programs which will multi-task but require the whole screen whenever they are accessed. DESQview 2 cost $269 and is available from Sourceware (02) 411 5711.



No multi-user applications have, to date, been written for PC-MOS. It is strictly a case of one task, one program — two users trying to run the same MS-DOS program or edit the same MS-DOS data file would soon encounter file corruption and system crashes.

Installation

Some warning of the difficulties you can experience installing PC-MOS is given when the manual suggests that you should appoint a technically competent system administrator. In theory, on a hard disk MS-DOS machine, PC-MOS can just be installed 'over' the current operating system.

According to the manual, installing PC-MOS is as simple as booting it from floppy disk and transferring the system using the .MSYS command in a similar way to the MS-DOS SYS command. I've tried this twice on two different machines and both times ended up with a non-booting machine that can't even be returned to MS-DOS. My suggestion for installing PC-MOS is back-up all your important files, do a low-level format on the hard disk and install it from scratch.

PC-MOS needs a minimum 386 configuration of 512k RAM and two floppy disks. However, there is very little you can do with that — in order to start getting the most out of it, you need at least 2Mbytes of RAM and a 20Mbyte hard disk.

Once installed, the first thing you need to do with PC-MOS is create a CONFIG.SYS file to inform it of your computer's configuration. The format of CONFIG.SYS will be familiar to MS-DOS users with such commands as BUFFERS, COUNTRY and DEVICE. Commands that won't be familiar include: SLICE, to define how much time is allocated to each task; SMPSIZE, to change the task supervisor's memory size; and FREEMEM, to inform the system of free memory ranges.

In use

One of the big selling points of PC-MOS is that it uses practically the same commands as MS-DOS — fair enough if you like an operating environment that dates back to the early 1970s and is probably the single most intimidating aspect to a new computer user. Frankly, I was hoping for something a bit more friendly.

All the old-favourite commands such as DIR, COPY CD and RENAMED are here, the only difference being that in PC-MOS they should be proceeded by a dot (.). There are, however, a few fundamental differences. If you really want to feel at home you can switch off the need for a dot, but this increases the time spent on executing each command.

PC-MOS improves upon the standard MS-DOS commands in a number of areas. One of the useful and yet simple extensions is the ability to scroll through previous commands by using the 'up cursor' key. This allows you to edit and re-issue commands as required. PC-MOS also increases the wildcard function available using the two commands .EXCEPT and .ONLY. For example, to delete all the files except .DOC file, you issue the command '.EXCEPT *.DOC DO .ERASE'.

The PC-MOS multi-tasking facilities are activated via a series of memory partitions set up by users. The command .ADDTASK creates a partition and has parameters to: specify the memory required; give the task a number (defaults to 1 plus the highest task currently running); give a security level to the task; specify a batch file for the task to run upon creation; specify the type of terminal a new user running under the task is using; specify the serial port of a user's terminal; and set the baud rate of a terminal. The Alt key and the numbers of the numeric keypad allow a user to access any task from the main console or from suitably configured workstations. Most parameters are optional — for example, 'ADDTASK 128' is enough to specify a single task of 128k. With each

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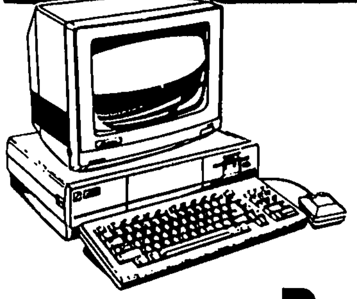

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PC-MOS offers no windowing system for the display of multi-tasking application, and each task takes over the entire screen when viewed. Once a task is launched, it is possible to adjust the size of memory allocated to it using the MOS SIZE command. From the DOS (PC-MOS) prompt it is possible to remove the task and get a complete map of all the tasks and what they are running.

PC-MOS offers more control over the multi-tasking environment than any other system I have used. For example, it is possible to adjust the amount of time each task is assigned. The default value of each time-slice is 1/18th of a second; this can be increased by the command MOSADM to around 14 seconds.

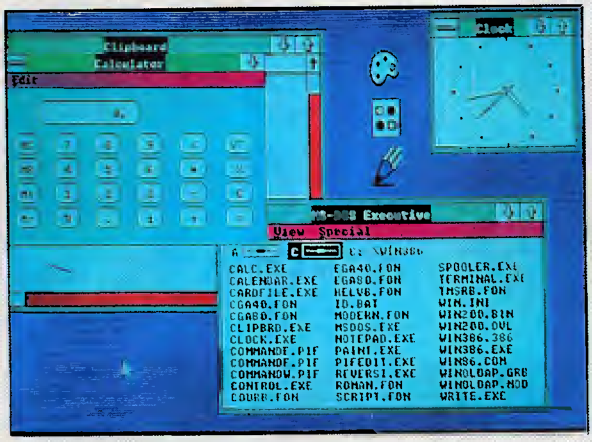
To further confuse things, it is also possible to change the priorities of tasks. The task with the highest priority will always get processing time before any task with a lower priority — of course, when waiting for input or writing to disk, there is plenty of time for the other tasks to run. It is imperative to restrict the access to these task commands, otherwise you will have users locking everybody else out of the system.

As far as MS-DOS applications are concerned, PC-MOS is not as compatible as might be desired. About half of the MS-DOS applications I tried worked satisfactorily, although this does include some notoriously badly-

Windows 386

Microsoft's first offering to the 386 software scene is Windows 386, a version of its graphics environment. Windows is a single-user multi-tasking environment that is capable of running existing MS-DOS applications but is really designed to run specially-written Windows applications. Windows applications make use of the WIMP (windows, icons, menus and pull-down menus). A variant of Windows will eventually be used as the standard front-end to Microsoft's OS/2 operating system, so if you are considering using OS/2, getting acquainted with Windows will probably ease the transition.

Windows 386 'feels' exactly the same as its lesser sibling, the soon to be announced Windows version 2.0. Release 2 of Windows introduces cosmetic changes to the system in that the 'tiling' system of window management has been replaced by overlapping windows. Under the tiling system, the entire desktop area is always covered by the open window. With Windows 2 and Windows 386, each window is individually resizable and movable in a similar way to the Apple Macintosh. It's surprising just how much easier Windows is to use because of this change.



```
A          C  C: \WIN386
CALC.EXE       EGA40.FON      SPOOLER.EXE
CALENDAR.EXE   EGA80.FON      TERMINAL.EXE
CARDFILE.EXE   HELV6.FON      TMSRB.FON
CGA40.FON      ID.BAT         WIN.INI
CGA80.FON      MODERN.FON     WIN200.BIN
CLIPBRD.EXE    MSDOS.EXE      WIN200.OVL
CLOCK.EXE      NOTEPAD.EXE    WIN386.386
COMMANDE.PIF   PAINT.EXE      WIN386.EXE
COMMANDF.PIF   PIFEDIT.EXE    WIN86.COM
COMMANDW.PIF   REVERSI.EXE    WINOLDAP.GRB
CONTROL.EXE    ROMAN.FON      WINOLDAP.MOD
COURB.FON      SCRIPT.FON     WRITE.EXE
```

Windows 386 uses the virtual 8086 mode of the 80386 processor for each task. Not only does this ensure that the full addressable memory space is used without the need for an extended memory scheme, but it should also mean that the failure of a single task is less likely to crash the entire system. Fortunately, I had a beta copy of a Windows application with which I could generate a situation that caused the whole system to crash. Sure enough, with Windows 386, everything else kept going and the application died within its own resizable window — very impressive. I couldn't find any way to close down the crashed window from here, but at least you can save all your other data files before re-booting.

Windows 386 will cost $392 and will be available in January from Microsoft on (02) 452 5088.

Multi-user, multi-tasking and concurrency

One of the most confusing aspects of computing is the definitions of multi-user, multi-tasking and concurrency. This is mainly due to manufacturers' over-optimistic claims, particularly those claiming that multi-tasking programs are, in fact, concurrent.

A **multi-user system** is one where a single processor looks after the activities of two or more users working via terminals. The terminals have little or no processing power of their own and are connected to the main system by a serial link. It is up to the main system to share its processor between all the users — obviously, the more users there are on a system, the more powerful the main system has to be. Multi-user systems are commonly confused with networks; however, a network consists of a number of systems — all with their own processing power — sharing common resources such as large-capacity hard disk, laser printers and modems.

A system is said to be **multi-tasking** when it gives the impression of running more than one application simultaneously. In fact, the processor is dividing its time between all the applications which are running, with each application waiting its turn to gain a few moments of the processor's time. The simplest form of multi-tasking is *time-slicing*, where each task is given the same amount of time. An alternative system uses priorities, and applications which require a lot of processing power can be given more time than, for example, an application that is busy printing.

With **concurrency**, a number of applications are actually running simultaneously. In order to do this the computer system needs multiple processors, at least one for each application running concurrently. *True* concurrency is still rare among microcomputers.

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behaved programs. Among the programs that *did* work were Lotus1-2-3, WordStar Release 4, dBase III, Harvard Graphics and PFS: Write. PC Outline, PC Write, the Microsoft Flight simulator, GEM and Windows proved too much for PC-MOS to handle. There is no support for programs that use the EGA graphics standard, so any EGA cards you have will spend the rest of their lives emulating the lesser CGA graphics standard.

To be fair to both TSL and Digital Research, the problems with EGA cards are not easily solved. Certain registers on the EGA graphics card are write-only (yes, write-only!) so there is no way of returning to a previous state of the card. In the majority of cases, a task could crash and not affect any other task; but even in this case it is hard to get the memory back to relaunch the task without rebooting the entire system.

The most worrying problem, however, is the number of times a single-task crash brought down the entire system (14 times over a period of three weeks). With a possible 25 users, that could be a lot of data lost.

PC-MOS can support a wide range of terminals. By far the most flexible terminal to use is the new Wyse 60 (or similar) which simulates IBM PC monochrome or CGA screens. Using one of these terminals, additional users should be able to run practically all applications. Using straight serial terminals restricts you to strictly text-based applications and then without fancy screen addressing.

As far as printing is concerned, PC-MOS maintains a printer spooler file — a list of everything awaiting printing which it feeds to the printer at a manageable rate. Two programs are used in this operation; a spooler and a print processor. The spooler is invoked in all tasks where spooled output is required; the print processor needs a task of its own dedicated to the spooling operation, and controls printing of spooled files.

PC-MOS has considerable facilities for the setting up of security if needed. You may secure files or entire directories from unauthorised use, and assign your own password and user ID codes. PC-MOS security lets you selectively determine levels of access for users to individual files, directories and multi-tasking partitions. If you are really concerned about the security of your system, however, you can encrypt files using a built-in encryption facility.

PC-MOS includes a text editor and debugger as standard with the system; both are considerable improvements over MS-DOS equivalents DEBUG and EDLIN.

Documentation & prices

One 300-page manual is included with PC-MOS/386 and, considering its size (small by operating system standards), it does a very good job. I was particularly impressed to find a number of occasions where TSL admits the limitations of PC-MOS and offers advice on how to overcome them.

PC-MOS costs $480 for a single-user volume, $1382.40 for a five-user system, and $2390.40 for 25 users, and is available from SPS on (02) 419 5879.

Conclusion

The first question you need to answer when deciding on 386 system software is: Do you want to go the whole hog and use the system as a multi-tasking, multi-user environment? If the answer is yes, then only Concurrent DOS and PC-MOS/386 will be able to provide this. If all you want to do is enhance the machine capabilities as a single-user environment, then both these products represent considerable overkill.

For a single user, the choice is between DESQview 2 and Windows 386. If you already have a collection of MS-DOS software, DESQview offers the best solution for getting the most out of it. Windows 386 is more likely to appeal to a new user who wants to be right up to date with current standards in applications software. When OS/2 finally becomes available, the number of Windows applications will boom.

As for the choice between Concurrent DOS 386 and PC-MOS/386, I reached the following conclusion. PC-MOS/386 is by far the most capable of the two systems. It offers up to 25 users, with each user capable of multi-tasking applications; it also offers a standard for the development of 32-bit software. The problem with PC-MOS/386 is that it's a bit flakey and I certainly wouldn't want to trust 25 users' data to it.

Concurrent DOS 386 is altogether less ambitious but, after years of development, it is a far more robust product. At the moment, my choice is Concurrent DOS 386 because of its reliability, but given another year's development, PC-MOS/386 will probably prove superior.

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Data compression competition

This month sees the last instalment of our compression tutorial series, and introduces a technique which is so impressive, it would appear to do the impossible. From here, it is up to each reader to attack the keyboard in search of the $30,000 prize.

In this series, we have examined a number of compression schemes of which each has certain advantages and disadvantages. The hardest task for a complete compression strategy, reflected in the letters we have received, is the challenge of producing a generalised mechanism which can *adapt* to various types of data.

The alternative encoding schemes, such as Huffman, assume a certain skewed distribution of byte values. While it is certainly possible and even feasible to construct a number of skew profiles and choose the best from block to block, there is the inherent aspect of predicting the nature of the data to be compressed. The corollary to this is that there may appear a block of data for which none of the skew profiles is appropriate. While a small number of profiles could deal with the great majority of data blocks found on the average disk, it is quite impractical to have a skew profile for all occasions. If we assume a block size of 512 bytes, there are no less than 10^{1233} possible combinations of contents. This is an incredibly large number. In fact, if you inscribed each combination on the side of one hydrogen atom, the entire collection would still weigh about 10^{1154} times as much as the universe. If this seems too amazing to be true, consider that if you take a humble Cray X-MP 64-bit integer and increment it one hundred million times per second, it will take just over 5000 years before it overflows.

So, any approach which tries to

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predict the contents of the data will meet only restricted success due to the sheer volume of possibilities. Any truly data-independent compression scheme needs to be *adaptive*.

The run length encoding techniques which identify contiguous repeated patterns such as 'AAAAA' or 'ABABAB' are completely adaptive and totally data independent. They provide very good degrees of compression when runs occur, but otherwise achieve nothing. Many blocks on a hard disk will contain extensive runs, but the majority will hold none of any significance. Run length encoding remains a good technique, but is not a total solution on its own. It is another string to your compression bow which should be applied when circumstances dictate.

We also examined a number of techniques which adapt the contents of each block, the most common and easily implemented being the simple repeated string replacement system. This approach scanned each block to locate strings of bytes (or bits) which occur more than once, and replaced them with individual codes. We even showed the most efficient way to construct such an algorithm, and techniques which allow the optimum string replacement table to be built.

String replacement readily achieves a very high degree of compression with very little effort. It is not uncommon to find a 512-byte block reduced to only 128 bytes. The catch is that the string expansion table must also be stored, and the size of this table becomes quite considerable, for example, it may be another 256 bytes. This would result in a total compressed size of 384 bytes and a compression ratio of only 25 per cent. In many cases the string expansion table will be larger than the compressed stream of tokens.

In conclusion, string replacement is absolutely great, except that it is necessary to store the table. It would be terrific if we could arrange to have smaller tables at the expense of a less efficient compressed stream.

This month, we look at a revolutionary technique which carefully builds a string replacement table and compresses the data, and then *throws the table away*. The decompressor is able to deduce what the table must have been.

Throwing it away

The approach we examine was originally derived by J Ziv and A Lempel in 1977, and was known as the Lempel-Ziv algorithm. It was further adapted by T Welch to produce a variation known as the LZW procedure.

```
Data:      THE CAT SAT ON THE MAT

Table:     0          ASCII 0
           1          ASCII 1
           2          ASCII 2
           .
           .
           .
           255        ASCII 255
           256        TH
           257        HE
           258        Espace
           259        spaceC
           260        CA
           261        AT
           262        Tspace
           263        spaceS
           264        SA
           265        ATspace
           266        spaceO
           267        ON
           268        Nspace
           269        spaceT
           270        THE
           271        EspaceM
           272        MA

Output:    T
           H
           E
           space
           C
           A
           T
           space
           S
           261
           space
           O
           N
           256
           258
           M
           261
```

Fig 1 Example of compression

This class of algorithm converts variable length strings of bytes into fixed length codes. Sometimes the codes may not be of fixed length, but will at least be of an easily predictable length. The various byte strings are selected such that all have an almost equal probability of occurrence, the objective being that the distribution of the output codes is not skewed.

The algorithms are adaptive in that they start with an empty string table and build the table from scratch during compression. Since the table is never stored, the algorithm also builds the table during decompression in such a way that the two tables are identical and the building of the decompression table is always one jump ahead of the decompressor's needs.

The entire procedure can be completed in a single pass and requires no prior knowledge of the input data, which would make the technique particularly appropriate for communications compression. The execution time can be made linearly proportional to the length of the data, which means that larger block sizes can be utilised without massive cost.

Conceptually, the input data should be broken into blocks of a relatively fixed size. The block size may vary, but the number of bits per output symbol should have been optimised for the chosen block size, and so too great a variation and many potential savings will be lost. Breaking the data into blocks means that the algorithm re-adapts to each new block of data, thereby coping with local effects within a single data stream.

The choice of block size is quite crucial, as with all adaptive schemes. At the start of the block while the algorithm is riding the worst of the learning curve, very little compression will be achieved. If too small a block size is chosen, the algorithm will spend all its time adapting to the data and very little time utilising its knowledge. Similarly, if the block size is too long the local characteristics of the data may change and the system will be attempting to compress based on an adaptation which is no longer valid. Experiments have shown that the optimal block size is around 5k, but that blocks as large as 30k and as small as 512 bytes can be equally effective.

The amount of data which can be handled by the system while it is still able to adapt to new characteristics is known as the *adaptive range*, and is primarily dependent upon the maximum size of the string table and the rapidity with which it is filled. The size of the table is entirely up to the implementor, but has certain trade-offs associated with it. The rate at which it is filled is dependent upon the data encountered.

The technique performs well over a large variety of file types. Measurements have shown results of 43 per cent for program source files (that is, the compressed data is 43 per cent of the original size), 66 per cent for object code, 47 per cent for internal numeric data, 55 per cent for text and between 50 and 16 per cent for general data files. The results obtained in a specific implementation will vary according to a number of design decisions, but should be roughly similar to those mentioned above. Additional gain may be achieved by utilising other methods,

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NOW IN MELBOURNE AT: GROUND FLOOR 11 QUEENS RD, MELBOURNE, 3001 TEL: (03) 820 9090 such as run length encoding or algorithmic transformation, either in conjunction with LZW, or as a replacement for LZW in situations where LZW breaks down.

Many other schemes will perform better than LZW in specific situations, but LZW remains a good all-rounder.

Implementation

The basis for the LZW technique is to scan the input data in chunks of 8 bits, build a string table as the scan proceeds, and output tokens whose size is greater than the input byte size, for example, 12 bits.

It is equally valid to consider the data in other than 8-bit chunks, for example, 4-bit or 16-bit chunks, but 8 bits are far easier to deal with initially. Similarly, the output symbols could be larger or smaller than 12 bits. A 12-bit code allows for 4096 entries in the string table, which seems ample. However, it is worth pointing out that the string table is far less efficient than one which might be generated by a traditional string replacement system. The impact of this is negligible, as the table is discarded, but does mean that 4096 entries may not be as ample as first seems. Moreover, the number of entries in the table determines the adaptive range of the implementation and therefore should be optimised for the chosen block size.

It is quite feasible to utilise a variable length output symbol. This is different from Huffman coding which utilises an unpredictable variable length code and therefore requires a highly structured and quite inefficient coding system. Huffman coding requires this because the decompressor has no prior knowledge, whereas LZW shares a common table even though the table is not stored. With LZW variable length codes, the size of the code can always be determined from the size of the string table at that point in time, specifically the CEIL($\log_2 N$), where N is the number of entries in the table and CEIL is a function which rounds up. Since the compressor and decompressor both build identical tables in an identical sequence, each will make the transition from one symbol size to another transparently and without any need for flagging in the output stream.

Implementing a variable length output symbol system is not as complicated as it seems. However, it would be best to start with a fixed length system and enhance it at a later time to incorporate variable length coding.

If the idea of dealing with 12 bits of data on an 8-bit character-set machine seems daunting, a word of explanation may be appropriate, for it is actually very easy. The input stream can be read in chunks of 8 bits simply by treating the input file as a file of characters, or a file of bytes if you're using one of the more modern languages. The output symbols can be maintained as 16-bit integers, that is, of type INTEGER in almost all languages. They can be manipulated, stored, moved and loaded simply as normal integers whose value may range between zero and 4095. The only special action is required when writing the numbers to the output file.

Initially, you may choose not to actually break the numbers into 12 bits, but write them as full integers and read them back in the same form. This does not achieve any compression, but for initial experimentation greatly simplifies the task of trying different symbol sizes. The size of the output file can be scaled by the ap-

```
Initialise table to all single length entries
Read first character into ¼MI½prefix¼D½
While not end of file
    Read next character into ¼MI½suffix¼D½
    If ¼MI½prefix+suffix¼D½ found in table
        Then
            ¼MI½prefix¼D½ := ¼MI½prefix+suffix¼D½
        Else
            ¼MI½index¼D½:= index of ¼MI½prefix¼D½ in table
            write ¼MI½index¼D½ to output stream
            add ¼MI½prefix+suffix¼D½ to table
            ¼MI½prefix¼D½ := ¼MI½suffix¼D½
    End while
¼MI½index¼D½ := index of ¼MI½prefix¼D½ in table
write ¼MI½index¼D½ to output stream
```

Fig 2 Compression algorithm

```
Initialise table to all single length entries
Read first token into ¼MI½token¼D½
¼MI½oldtoken¼D½ := ¼MI½token¼D½
¼MI½finaltoken¼D½ := ¼MI½token¼D½
Output ¼MI½token¼D½
While not end of tokens
    Read next token into ¼MI½token¼D½
    ¼MI½newtoken¼D½:= ¼MI½token¼D½
    If ¼MI½newtoken¼D½ not yet in table then
            Push ¼MI½finaltoken¼D½ onto stack
            ¼MI½token¼D½ := ¼MI½oldtoken¼D½
    While length of table entry for ¼MI½token¼D½ above 1
        Push suffix entry of ¼MI½token¼D½ onto stack
        ¼MI½token¼D½ := ¼MI½ prefix entry of ¼MI½token¼D½
    Output ¼MI½token¼D½
    ¼MI½finaltoken¼D½ := ¼MI½token¼D½
    While stack not empty
        Output pop from stack
    Add ¼MI½oldtoken¼D½ to table as prefix
    Add ¼MI½token¼D½ to table as suffix
    ¼MI½oldtoken¼D½ := ¼MI½newtoken
    End while
```

Fig 3 Decompression algorithm

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```
1000 '      LZW Compression Algorithm Demonstration
1010 '
1020 '      APC Magazine, December 1987.
1030 '
1040 '
1050 '
1060 DEFINT A-Z
1070 MAXTABLESIZE = 1024                            ' Max entries in table
1080 MAXBLOCKSIZE =  512                            ' Size of data block
1090 MAXSTACKSIZE =  256                            ' Size of Stack
1100 DIM TABLE$[MAXTABLESIZE]                       ' String table
1110 DIM SOURCE$[MAXBLOCKSIZE]                      ' Original Data
1120 DIM COMPRESSED[MAXBLOCKSIZE]                   ' Compressed Data
1130 DIM DECOMPRESSED$[MAXBLOCKSIZE]                ' Decompressed
1140 DIM STACK[MAXSTACKSIZE]                        ' Stack
1150 DIM OUTPREFIX[MAXTABLESIZE]                    ' Decompressor Prefix Table
1160 DIM OUTSUFFIX$[MAXTABLESIZE]                   ' Decompressor Suffix Table
1170 TABLESIZE = 0                                  ' Initialise to empty
1180 STACKSIZE = 0                                  ' Stack empty
1190 SOURCESIZE= 0                                  ' Source buffer empty
1200 COMPRESSEDSIZE = 0                             ' Output buffer empty
1210 DECOMPRESSEDSIZE = 0                           ' Verification buffer empty
1220 OUTTABLESIZE = 0                               ' Decompressor Table empty
1230
1240 GOSUB 1340                                     ' Load Source Buffer from File
1250 GOSUB 1510                                     ' Initialise string table
1260 GOSUB 1740                                     ' Compress the data
1270 GOSUB 2020                                     ' Report on Results
1280 GOSUB 2290                                     ' Decompress data
1290 GOSUB 2720                                     ' Check result
1300 '
1310 END
1320 '
1330 '
1340 ' Subroutine to load SOURCE buffer and set SOURCESIZE
1350 '
1360 INPUT "Enter file name: ", FILENAME$
1370 IF FILENAME$="" THEN STOP
1380 OPEN "R", #1, FILENAME$,1
1390 FIELD #1, 1 AS FILEINPUT$
1400 GET #1
1410 WHILE (NOT EOF(1)) AND (SOURCESIZE < MAXBLOCKSIZE)
1420        SOURCESIZE = SOURCESIZE + 1
1430        SOURCE$[SOURCESIZE] = FILEINPUT$
1440        GET #1
1450        WEND
1460 CLOSE #1
1470 PRINT "Loaded "; SOURCESIZE; " 8-Bit Bytes into buffer"
1480 RETURN
1490 '
1500 '
1510 ' Subroutine to Initialise String Table
1520 '
1530 FOR I= 0 TO 255                                ' For simplicity, load
1540     TABLE$[I] = CHR$(I)                        ' first 256 table entries
1550     NEXT I                                     ' with their byte values
1560 TABLESIZE = 255
1570 RETURN
1580 '
1590 '
1600 ' Subroutine to find the string FIND$ in the TABLE$[]
1610 '            Returns result in POSITION, or -1 if not found.
1620 '
1630 IF LEN(FIND$)=1 THEN
  :    POSITION=ASC(FIND$)
  :    RETURN                                       Optimise first 256 entries
1640 POSITION =-1
1650 I=TABLESIZE                                     Else exhaustive search
1660 WHILE (POSITION = -1) AND (I>255)
1670        IF TABLE$[I] = FIND$ THEN POSITION = I
1680        I = I - 1
1690        WEND
1700 RETURN
1710 '
1720 '
1730 '
1740 ' Subroutine to compress SOURCE[] into COMPRESSED[]
1750 '
1760 PRINT
1770 PRINT
1780 S$ = SOURCE$[1]
1790 FOR SCAN=2 TO SOURCESIZE
1800     PRINT "Compressing Byte "; SCAN;
1810     LOCATE CSRLIN,1
1820     IF TABLESIZE = MAXTABLESIZE THEN
  :        COMPRESSEDSIZE = COMPRESSEDSIZE + 1
  :        COMPRESSED[COMPRESSEDSIZE] = ASC(SOURCE$[SCAN])
  :        GOTO 1940                                                  table full
1830     FIND$= S$ + SOURCE$[SCAN]
1840     GOSUB 1600                                                 ' search table
1850     IF POSITION <> -1 THEN
  :        S$ = S$ + SOURCE$[SCAN]
  :        GOTO 1940                                                ' if found
1860     TABLESIZE = TABLESIZE + 1                                  ' else add it
```

Fig 4 Basic implementation of the LZW algorithm

propriate amount: for example, divide by 16 and multiply by 12 to convert a full integer file to the size that file would be if written efficiently.

Of course, you could not actually send the program to *APC* in that form, so eventually you will have to read and write 12-bit quantities. This is done through simple shift and mask operations. If your selected language does not include these operations, just remember that multiplying by two is equivalent to shifting one bit to the left; dividing by two has the same effect as shifting to the right; and that AND and OR operators often behave bit-wise and can be used directly for masking purposes.

If you choose to utilise variable length codes, then generalised *read-bit* and *write-bit* procedures will be appropriate. A global variable can keep track of the current symbol size, and these procedures can automatically deal with the required number of bits. Of course, the bit twiddling is only necessary for input and output operations. Internally, these quantities may be maintained directly as 16-bit values which simplify programming and enhance performance.

Additionally, it does not really matter how you write the bits to the file, so long as you read them back the same way. You could write them MSB first or LSB first and it would make no difference as the only program which will process the compressed file is the decompressor.

Moreover, the system could be constructed to deal with local variations in an intelligent fashion. We have said that long block sizes are good because they provide the maximum opportunity to gain from the learned experience, but that can also be bad when the data characteristics alter dramatically late in the adaptive range. It is, however, entirely feasible to build a system which utilises a variable block size.

This could be done by having a notionally large block, say 32k. A mechanism could then be implemented to allow the system to 'abandon' the block should the local characteristics change. The only tricky part is to know when a block should be abandoned. It is likely that some blocks will have 'rough spots' in the middle but then return to a data profile which matches that which was initially adapted to at the start of the block. Abandoning a block too early is as bad as hanging on to one too long. Therefore an ideal system would persist with a block until it became patently obvious that something had gone wrong, and then back-

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track through the block to the point where things started going off the rails.

Determining when to abort the block is relatively easy since the system can automatically maintain statistics concerning its average degree of compression. Initially this statistic will not look very good as the algorithm traverses its learning curve. However, the general trend of the statistic should be towards better results as the block progresses. If the average degree of compression over the entire block suddenly takes a nose dive, then you know it is time to get out. A very elaborate system could even maintain N concurrent tables commencing from N different starting points, and score each one at the same time. This would allow it to chose optimal starting and stopping points.

Why it works

The LZW algorithm all seems a little like black magic. The reason it works is a simple one, although it deserves a little thinking about. The whole scheme depends on a single property of the string table. If any string is in the string table, then it must also be true that the string which is one character shorter than the first string must also be in the table. And that's the secret!

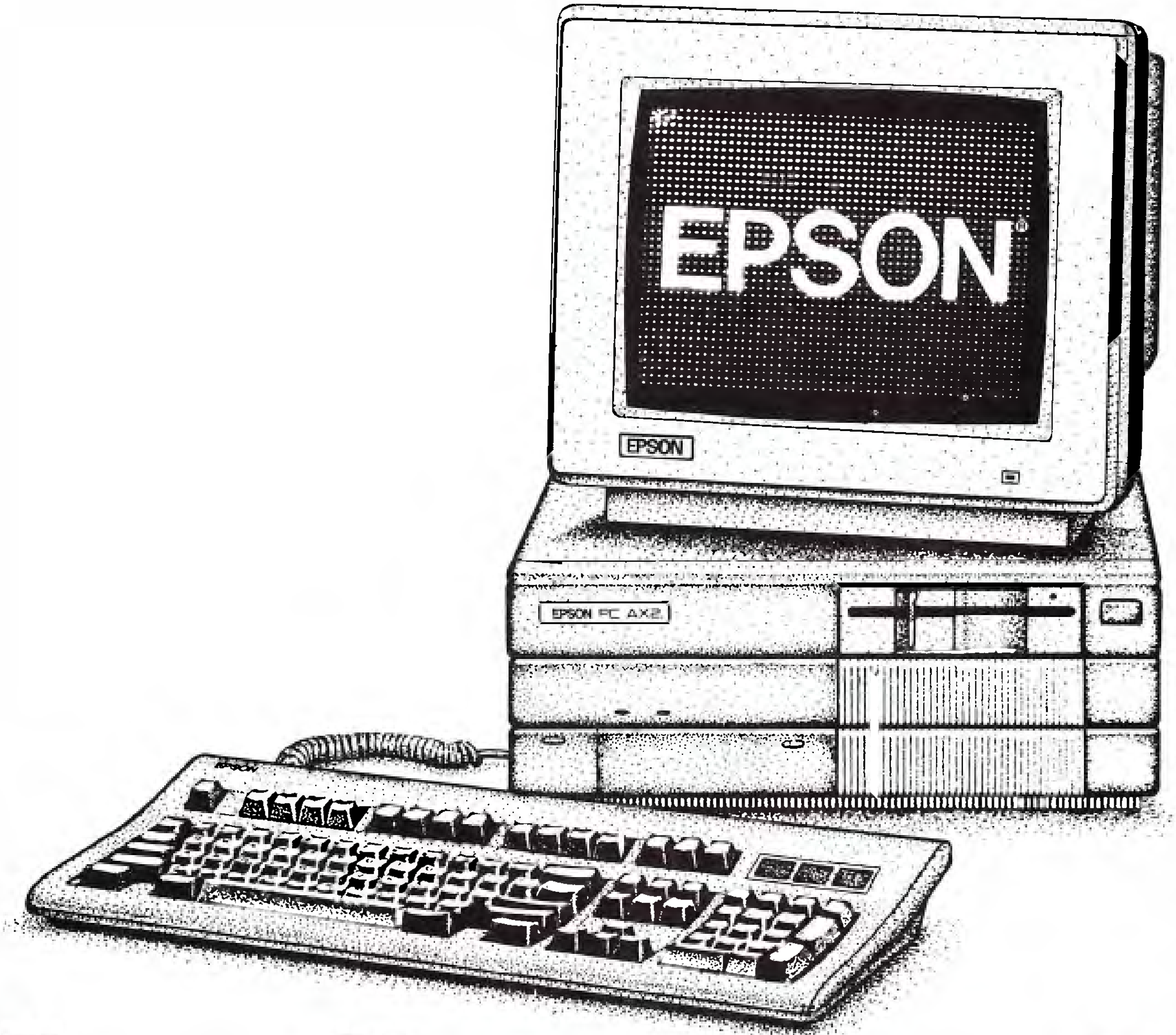
Fig 1 shows an example of a string to be compressed. The string is very short, and so the algorithm has little time to adapt. Nevertheless, the data is also fairly redundant and so savings, albeit small, are made.

Notice that the table created is incredibly inefficient. Literally everything goes into it. But since the table is never stored, this is of no consideration. Notice also that in order for a string to be entered in the table, its *prefix* string must also be in the table. That is, a string which is identical to the first string but one character shorter.

In the compressed data stream, the level of success in the early stages of the file is quite unremarkable. However, towards the end of the data stream, four output tokens are able to represent no less than seven input bytes. The system is not able to return to the early portion and utilise its final level of knowledge to achieve uniform effectiveness over the entire data set, as in order for the whole scheme to work, only one new byte may be added in one step. Otherwise the decompressor's ability to deduce the compression table would be lost and the table would have to be stored.

Since only one new byte of string length may be added at any one time,

```
1370      TABLE$[TABLESIZE] = S$ + SOURCE$[SCAN]
1880      FIND$ = S$
1890      GOSUB 1600                                              search table
1900      IF POSITION = -1 THEN PRINT "table error" : STOP        must find it
1910      COMPRESSEDSIZE = COMPRESSEDSIZE + 1                     and output
1920      COMPRESSED[COMPRESSEDSIZE] = POSITION
1930      S$ = SOURCE$[SCAN]                                      reset string
1940      NEXT SCAN
1950 FIND$ = S$
1960 GOSUB 1600
1970 COMPRESSEDSIZE = COMPRESSEDSIZE + 1
1980 COMPRESSED[COMPRESSEDSIZE] = POSITION                        emit last
1990 RETURN
2000
2010
2020   Subroutine to report on compression results
2030
2040 COMPRESSEDBYTES = CINT((COMPRESSEDSIZE*1.5)+.5)              round up
2050 COMPRESSEDRATIO = COMPRESSEDBYTES/SOURCESIZE * 100
2060 OPTIMUMBITS = 0
2070 I=TABLESIZE
2080 WHILE I > 1
2090        OPTIMUMBITS=OPTIMUMBITS + 1
2100        I = I / 2
2110        WEND
2120 OPTIMUMBYTES = CINT((COMPRESSEDSIZE/8*OPTIMUMBITS)+.5)
2130 OPTIMUMRATIO = OPTIMUMBYTES/SOURCESIZE * 100
2140 PRINT
2150 PRINT
2160 PRINT "Original size in bytes........... ";USING "#####"; SOURCESIZE
2170 PRINT "Number of output tokens.......... ";USING "#####"; COMPRESSEDSIZE
2180 PRINT "Number of table entries used..... ";USING "#####"; TABLESIZE
2190 PRINT "Output bytes using 12-bit tokens.. ";USING "#####"; COMPRESSEDBYTES
2200 PRINT "Optimum bits per token was....... ";USING "#####"; OPTIMUMBITS
2210 PRINT "Ouput size using optimum tokens... ";USING "#####"; OPTIMUMBYTES
2220 PRINT
2230 PRINT "Compression ratio (12-bits)...... ";USING "###.#"; COMPRESSEDRATIO
2240 PRINT "Compression ratio (Optimum)...... ";USING "###.#"; OPTIMUMRATIO
2250 RETURN
2260
2270
2280
2290   Decompress COMPRESSED[ ] into DECOMPRESSED$[ ]
2300
2310 FOR I = 0 TO 255                                             Reset Table
2320      OUTPREFIX[I] = 0
2330      OUTSUFFIX$[I]= CHR$(I)
2340      NEXT I
2350 OUTTABLESIZE = 255
2360 CODE = COMPRESSED[1]
2370 OLDCODE = CODE
2380 FINCHAR = CODE
2390 DECOMPRESSEDSIZE = DECOMPRESSEDSIZE + 1
2400 DECOMPRESSED$[DECOMPRESSEDSIZE] = CHR$(CODE)                  emit first
2410 PRINT
2420 PRINT
2430 FOR SCAN= 2 TO COMPRESSEDSIZE
2440      PRINT "DeCompressing Token "; SCAN;
2450      LOCATE CSRLIN,1
2460      CODE = COMPRESSED[SCAN]
2470      INCODE = CODE
2480      IF CODE > OUTTABLESIZE THEN
  :          STACKSIZE = STACKSIZE + 1
  :          STACK[STACKSIZE] = FINCHAR
  :          CODE = OLDCODE
2490      WHILE CODE > 255
2500            STACKSIZE = STACKSIZE + 1
2510            STACK[STACKSIZE] = ASC(OUTSUFFIX$[CODE])
2520            CODE = OUTPREFIX[CODE]
2530            WEND
2540      DECOMPRESSEDSIZE = DECOMPRESSEDSIZE + 1
2550      DECOMPRESSED$[DECOMPRESSEDSIZE] = CHR$(CODE)
2560      FINCHAR = CODE
2570      WHILE STACKSIZE > 0
2580            DECOMPRESSEDSIZE = DECOMPRESSEDSIZE + 1
2590            DECOMPRESSED$[DECOMPRESSEDSIZE] = CHR$(STACK[STACKSIZE])
2600            STACKSIZE = STACKSIZE - 1
2610            WEND
2620      OUTTABLESIZE = OUTTABLESIZE + 1
2630      OUTPREFIX[OUTTABLESIZE] = OLDCODE
2640      OUTSUFFIX$[OUTTABLESIZE]= CHR$(CODE)
2650      OLDCODE = INCODE
2660      NEXT SCAN
2670 PRINT
2680 PRINT "Decompressed size in bytes........ ";USING "#####";DECOMPRESSEDSIZE
2690 RETURN
2700
2710
2720   Compare SOURCE$[ ] and DECOMPRESS$[ ]
2730
2740 GOOD$="Yes"
2750 IF SOURCESIZE <> DECOMPRESSEDSIZE THEN GOOD$ = "No" : GOTO 2790
2760 FOR I=1 TO SOURCESIZE
2770      IF SOURCE$[I] <> DECOMPRESSED$[I] THEN GOOD$="No"
2780      NEXT I
2790 PRINT "Original = Decompressed..........        "; GOOD$
2800 RETURN
```



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the table is initialised to contain all strings of length one. That is, all ASCII characters in the range zero to 255.

The implication of the fact that for any string, the table will also contain all possible prefix strings implies an important point on how the table may be organised. The point is that the table may either be organised as a simple table in which each entry contains a single variable length string, or with each entry as a pair of codes, one for the prefix of the string and one for the suffix. In the case of the paired entries, the suffix is the code of a simple byte in the range zero to 255, and the prefix is a reference to another entry in the table. The other entry may, itself, consist of a prefix and a suffix.

In one case, we have the overhead of maintaining variable length strings for the benefit of always having the full expanded meaning of the code at our fingertips. In the other case, we have the desirability of each entry in the table being of a fixed length while suffering the implications of a recursive expansion for each entry.

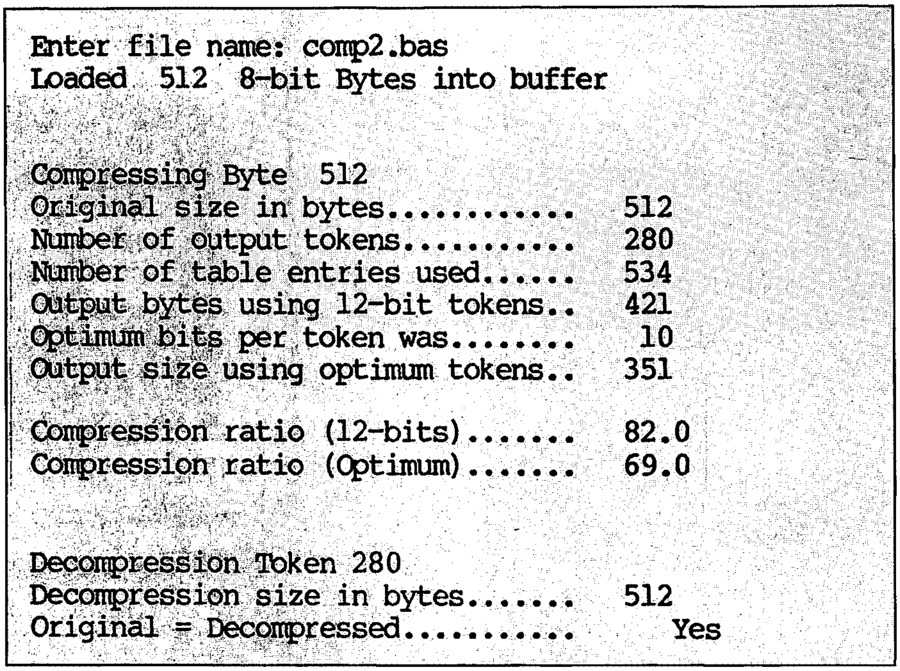
As it happens, the flat string approach is appropriate for compression, and the recursive pair approach is appropriate for decompression. Therefore we utilise both.

Figs 2 and 3 show the algorithms expressed in pseudocode for both compression and decompression. The compression algorithm maintains the current unit of input as a prefix and a suffix, while maintaining the table entries as complete strings. For each input unit, if the combination of the prefix and the suffix is already present in the string table, then no code is output and the combination of the two becomes the new prefix, with an additional input byte being read to form the suffix. When finally the concatenation of the prefix and suffix is not found in the table, then it is added and the index of the prefix is output to the compressed stream. The new prefix then becomes the old suffix, an individual character, the addition of which caused the combination not to be found. The whole process repeats until the input is exhausted.

In this way, the table continues to grow with one new element of repeated data being added in each step.

The decompression algorithm is slightly more complex, and consists of reading the compressed tokens taking advantage of the fact that, at most, one unknown character will be added each time. The protocol by which the table grows is identical to the compressor, and therefore the same table is built. A stack is maintained to allow expansion of compound symbols.

Each new code is accepted and broken into its prefix and suffix components. The suffix will *always* equate to an atomic byte, and so the prefix is separated from it and, in turn, decomposed in a similar fashion. The whole process is recursive until the prefix also results in an atomic code value, that is, one in the range zero to 255. This final token is the byte first encountered by the compressor and therefore must be output first. When it is encountered, all intermediate suffixes placed on the stack may be pulled off and added to the output stream.



```
Enter file name: comp2.bas
Loaded 512 8-bit Bytes into buffer


Compressing Byte 512
Original size in bytes...........   512
Number of output tokens..........   280
Number of table entries used.....   534
Output bytes using 12-bit tokens..  421
Optimum bits per token was.......    10
Output size using optimum tokens..  351

Compression ratio (12-bits).......  82.0
Compression ratio (Optimum).......  69.0


Decompression Token 280
Decompression size in bytes......   512
Original = Decompressed..........      Yes
```

Fig 5 Running the LZW program

In practice

The algorithm is simple, and necessarily so if the process of table construction is to be reversible during de-compression. This simplicity means that good performance can be relatively easily achieved.

Fig 4 shows a Microsoft GW-Basic program to compress individual blocks of data according to the algorithm we have described. The variable MAXTABLESIZE determines the notional maximum size of the string table. When the table is full, the system is no longer able to adapt to new characteristics of the data. Ideally, the table should never get full and the system should maintain a degree of adaptability throughout the entire data stream. Indeed, because the string table is of such a low quality (but remember, we throw it away), it is crucial to the success of the operation that the table does not fill.

The variable MAXBLOCKSIZE determines the maximum amount of data the program is able to compress. The program simulates the compression of a single block only, and consequently reads from the input file only until MAXBLOCKSIZE bytes have been loaded. If less than that number of bytes is available in the file, then the block will be used in its shorter form. The variable SOURCESIZE reflects the actual number of bytes loaded into the array SOURCE$[]. We have utilised string arrays in all cases where the contents of the array are a single 8-bit, unencoded quantity. The only exception to this is the array TABLE$[], which is a true string table and holds the table built and utilised by the compressor.

The variable MAXSTACKSIZE determines the maximum allowable size of the decompressor stack, which is the maximum length of a string to be represented by a single token.

The major data structures in the program are TABLE$[], which is the compressor string table, SOURCE$[], the input block, and STACK[], the decompressor stack. Additionally, COMPRESSED[] holds the compressed output, and DECOMPRESSED$[] holds the result of decompression which should be equal to SOURCE$[]. The

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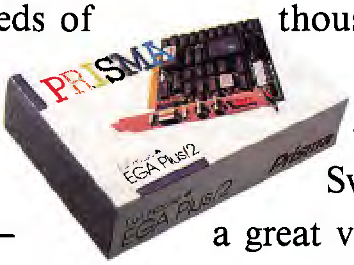

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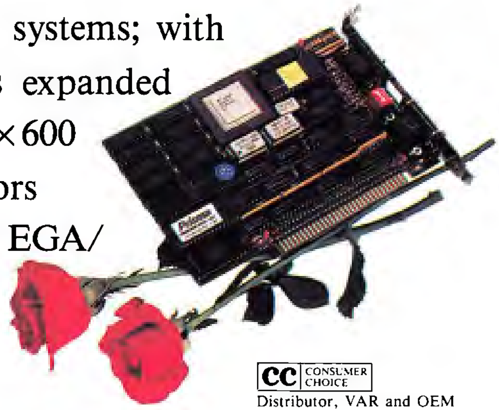

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two arrays OUTPREFIX[] and OUTSUFFIX$[] form the string table for the decompressor in a recursive format. Elements of OUTSUFFIX$[] are always atomic bytes, whereas OUTPREFIX[] elements are themselves references into other elements of OUTSUFFIX$[] and OUTPREFIX[].

The program is divided into five major subroutines. The routine commencing at line 1340 reads from the nominated input file until either the file is exhausted or MAXBLOCKSIZE bytes have been read. The file is treated as a random access file and read using GET#, thereby allowing to read past CHR$(26) or control Z until the physical end of file has been encountered. As such, the program may be used on files of any type.

The routine at line 1740 implements the compressor, exactly according to the algorithm shown in Fig 3. It reads from the array SOURCE$[] and outputs to the array COMPRESSED[]. It calls the subroutine at line 1600 to perform table searches. This subroutine is passed a string in the variable FIND$ and returns a result in the variable POSITION, being either the index of the string in the compressor table, or –1 if the string were not found. The first 256 entries of the table are optimised, since we know that they will always be found at the subscript equal to their simple ASC() values. The first 256 entries must always be of length one as that is how we initialised the table. For non-simple entries, the table is searched backwards until a match is made.

Starting at line 2290, we see the routine to perform the decompression which reads from the array COMPRESSED[] and writes its results to DECOMPRESSED$[]. It utilises OUTPREFIX[] and OUTSUFFIX$[] to build its table, and STACK[] for its partially expanded tokens. Again, the program follows exactly the algorithm shown in Fig 3.

The routine at line 2720 performs a comparison between SOURCE$[] and DECOMPRESSED$[], ensuring they are the same size and byte for byte identical. This is an essential stage of any compression system, as it is relatively easy to achieve high rates of compression which do not decompress back into their original form, or do so only for a select subset of data. When testing your compression schemes *always* include an automated verification stage, as the results can otherwise be very misleading.

Finally, the routine at line 2020 reports on the compression achieved. The program nominally outputs 12-bit tokens in line with the 4096 entry maximum table size. This routine displays the number of bytes read, the number of tokens output and the resultant output file size using 12-bit tokens. It also displays the compression ratio as a percentage. Additionally, this routine calculates the optimum final token size in bits based on the number of entries in the table at the completion of the block. It then displays the output file size which would be achieved using this optimum token size and the corresponding compression ratio. The optimum size is calculated as the upwards rounded result of Log_2N.

Note that the optimum final token size is not the actual file size which could be achieved, as the token size will actually vary throughout the block. Thus although the final optimum (at the end of the block) may be 11 bits, the output will also have had a significant proportion of 9 and 10-bit tokens. Subsequently the exact optimum file size must be accumulated throughout the run.

The output tokens are not actually written to a file, as to do so is trivial and secondary to the technique being demonstrated. Rather, the tokens are kept in the COMPRESSED[] array and a gentleman's agreement exists between the compressor and decompressor not to peek in each other's tables.

Fig 5 shows a sample run of the program, compressing the first 512 bytes of itself.

Tuning

The program presented runs quite slowly in interpretive Basic, in fact unacceptably so. An analysis of where it spends its time shows that the decompressor has no performance problems other than the interpretive nature of the language. The decompressor always accesses its table by subscript and never searches, and hence its performance is always completely linear.

The compressor, on the other hand, often searches its table by content rather than subscript. As the table size increases, so the average sequential search time increases. This results in something approximating an exponential performance curve as the compression of the block proceeds.

There are, however, several techniques which can be employed to dramatically improve this situation. Specifically, an index can be built on top of the compressor table.

Two types of index are immediately apparent. One uses the first byte of the string entries to provide access to a linked list of all entries which also commence with that byte. The other utilises a linked list to chain together all strings of an equal length. The overheads involved in maintaining this index are negligible, and the performance improvements are significant — at least a factor of 20 or 30. Alternatively, both techniques could be combined to reduce the resulting search paths even more, although the memory requirements may be prohibitive. A third alternative is to utilise hashing.

Since the performance bottleneck is very well isolated, specific action can be taken to improve that particular portion without disrupting or over-complicating the rest of the algorithm. Implementations of this algorithm complete with a small number of optimisations have had no trouble in compressing 512 bytes in less than three seconds on a standard IBM PC utilising a compiled language.

Higher degrees of compression can be achieved through not initialising the first 256 entries of the string table. This complicates the logic somewhat, but does yield better results within a skewed character distribution. As we have said that most blocks of a reasonable size (say 512 bytes) contain at least a 50 per cent skew, this added complication is likely to dramatically reduce the average token length over a complete block, as well as prolonging the adaptive range.

Conclusion

The technique we have presented in this, our final instalment in the series, is one of the newest and least known compression schemes.

It is not, however an end in itself.

Rather, we hope it demonstrates how a potentially unreasonable idea can be made to work quite successfully. We hope that it may form the basis for your selected scheme, and more importantly, may inspire you to follow one or two of those seemingly ridiculous ideas you may have had under the shower. Computer science is an exciting field precisely because these sorts of ideas can be made to work through loopholes in the universe.

From here, it is up to you. We'll be giving away $30,000 to the best entry, and we wouldn't be too surprised at which entry pulls off the cash.

Best of luck.

END

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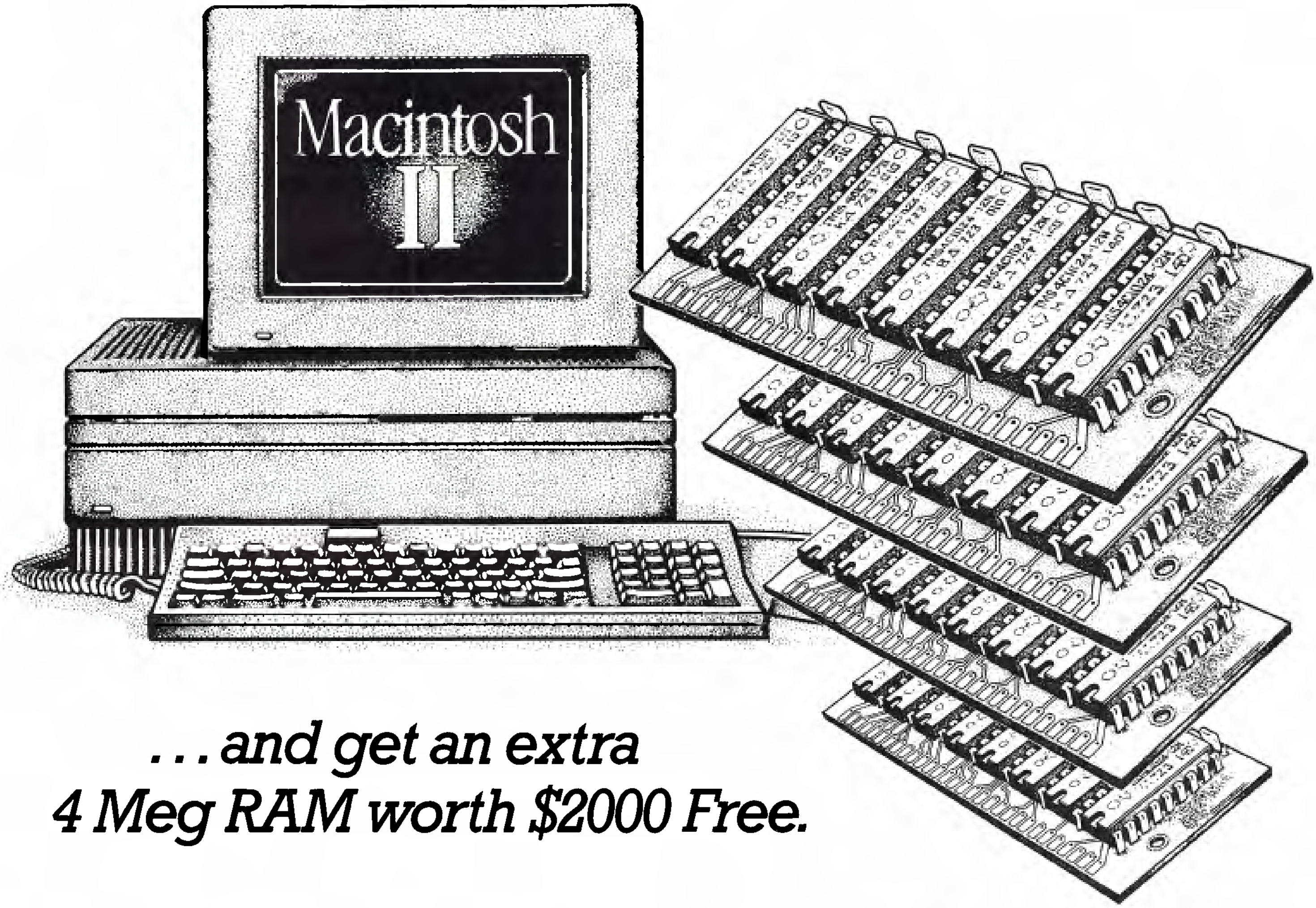

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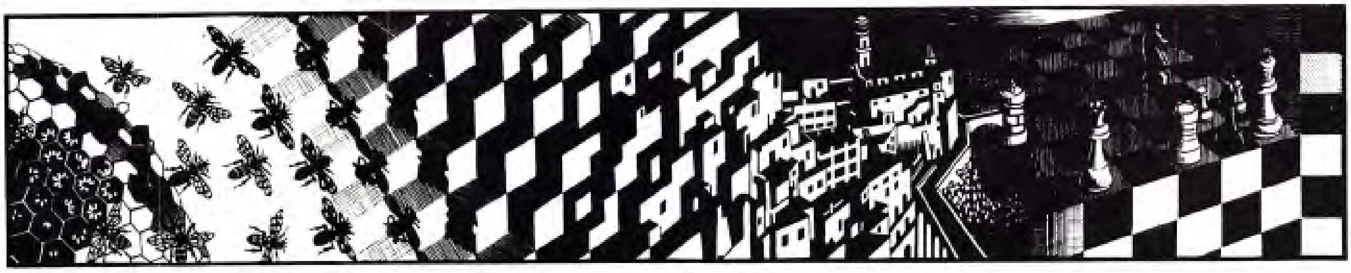


Confusion prevails as Stephen Applebaum grapples with life as an orc and serves time as an sorcerer's apprentice, all in this month's selection of games

Orc talk

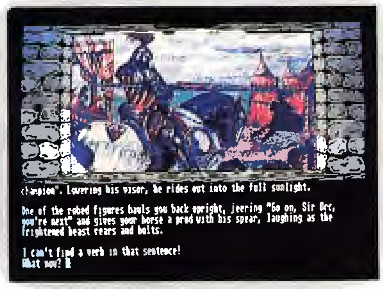
Title: Knight Orc
Computer: Atari ST;
Commodore 64/128; Amiga;
Amstrad; IBM PC
Supplier: ISD
Price: $54.95 (C-64/128, Amstrad, Atari); $69.99 (IBM PC, Amiga)

Orcs are notorious for their bad manners, evil smell and penchant for attacking humans. Unlikely though it is, however, orcs may just possibly be the victims of bad PR. It is difficult to tell, when every programmer depicts them as a *bête noir.* But all that is set to change, because, after years of suffering at the mercy of sword-swinging machismos, the orc's day has finally come. Level 9 has buried the hatchet (and this time not between an orc's ears) and produced Knight Orc, an outstanding graphical adventure which casts the player in the role of an orc.

Knight Orc is the best graphics/text adventure to come out of Level 9 so far. The company's other attempts at putting pictures into its programs have, on the whole, been extremely poor.

The graphics on the disk version of Knight Orc are a far cry from the crude line drawings of the Silicon Dreams trilogy. Instead of using a computer to draw the program's pictures, Level 9 employed an artist to paint some original designs, which it then digitised. This process has a mellowing effect on the 'paintings', so that they look as if they have been photographed with a soft focus lens. Although not as arresting as the graphics in 'The Pawn' and 'The Guild of Thieves', they make an interesting *divertissement* from the game's mammoth chunks of text.

The game follows the trials and tribulations of a particularly — even by orc standards — ugly character called Grindleguts. At the Orc's Head Inn Grindleguts is volunteered as the orc champion by his friends, whereupon he is tied to a horse in readiness to joust a human knight. The adventure begins the following morning when you, Grindleguts, awake from your drunken stupor and discover the not so jolly prank you have been dupe to.



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champion". Lowering his visor, he rides out into the full sunlight.

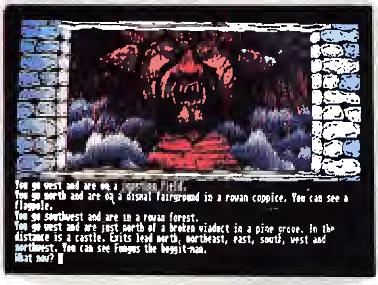
One of the robed figures hauls you back upright, jeering "Go on, Sir Orc,
you're next" and gives your horse a prod with his spear, laughing as the
frightened beast rears and bolts.

I can't find a verb in that sentence!
What now? █
```

Grindleguts's adventures are told in three episodes. In Loosed Orc, the first chapter, you must collect pieces of rope and tie them together to make a single rope long enough to enable you to cross a broken viaduct and return home to your friends.

The second and third parts, A Kind of Magic and Hordes of the Mountain King respectively, are linked and can be passed between at will. Your objective in these two phases is to learn 21 magic spells, recruit other characters and solve the secret of your true persona. The game's *dénouement* is truly unique, and makes for one of the weirdest and most imaginative final twists I have seen in a computer game to date.

In Knight Orc, Level 9 has departed dramatically from the conventional style of adventure gameplay. Mapping, for instance, is normally a beneficial, if tedious, exercise. In Knight Orc, you are actually advised not to make a map, because, unlike the majority of adventures on the market, Knight Orc features a system whereby it is possible to move to a location, object or character simply by typing GOTO <place>. And if an object has been moved by another character, then you need only type FIND <object> to locate it. Similarly, you can follow characters about, wait for them and even ambush them, just by using a few simple built-in commands.



```
You go west and are on a jousting field.
You go north and are on a dismal fairground in a rowan coppice. You can see a
flagpole.
You go southwest and are in a rowan forest.
You go west and are just north of a broken viaduct in a pine grove. In the
distance is a castle. Exits lead north, northeast, east, south, west and
northwest. You can see Fungus the boggit-man.
What now? █
```

If all this sounds too simple, I can assure you that it is not. Simple commands are necessary because of the way the game's 70 characters operate. While you are moving about the world of Knight Orc, performing deeds of violence and cowardice, so too, are they. Treasure secreted about the game is not there simply for your benefit: the inhabitants, too, want a cut of the profits and they are not above killing an orc, particularly one as gruesome as Grindleguts, to get it.

In Loosed Orc you have a helper name Denzyl. He is a bit dim-witted but on the whole does what you ask. Denzyl, like the other characters, can be spoken to using multi-clause sentences. You can ask him to go and perform a task, such as finding and bringing back a specific object. While he is off doing your bidding, you can continue on your way, since he will usually find you wherever you are.

Denzyl and everyone else in Knight Orc have their own personality and purpose in life. It is not rare to come across someone drunk from having spent too long at the local tavern. There is even the possibility that Denzyl might bungle a task set him because he decides to pop in for a few jars on the way back to you. Nothing is certain in Knight Orc.

Death in Knight Orc is more embarrassing than tragic. When you croak, a Valkyrie descends and carries you into the clouds where you are sneered at for your ugliness and sent directly back to earth, dispossessed of everything you accumulated before passing over. All is not lost, though, because you need only return to the spot where you died to reclaim your belongings. Level 9, after living in the shadows of some of the bigger names, has finally emerged with an adventure destined for a bright future.

Wizard wheeze

Title: King's Quest III: To Heir Is Human
Computer: Apple II series; Amiga; IBM PC
Supplier: Ozi Soft/Busiware
Price: all versions $49.95

Sierra On-Line's latest 3-D adventure, King's Quest III, follows hot on the heels of parts I and II, both of which were extremely popular. If you read the small print on the game's packaging, though, you will find the sentence 'Completion of King's Quest I and/or II not required'.

If you take it on its own merits, and ignore the fact that it is little more than a variation on 'parts' I and II, King's Quest III is actually one of the most technically accomplished and challenging arcade adventures to surface in a long time.

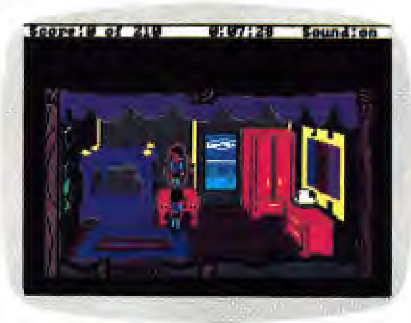
King's Quest III differs considerably from conventional graphic/text adventures such as The Pawn since it is played by moving an animated character about the game's locations using a joystick rather than typed movement commands.

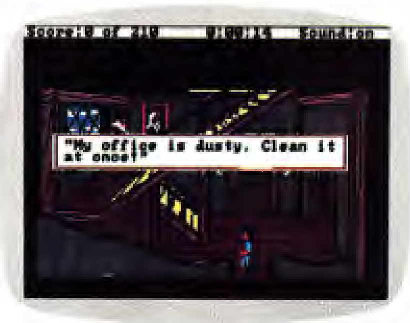
Only when you want to interact with people or objects do you have to type anything. Actions such as examining an object, communicating with other characters and buying and selling all require the keyboard.

Although billed as '3-D', King's Quest III is really nothing of the sort, because scant attention was paid to perspective. When the hero walks into the distance, he does not appear to get smaller, as in the real world. Instead he remains the same size.

In the adventure you play an enslaved youth named Gwydion. For 18 years he has been in the thrall of Manannan, an evil wizard who presides malevolently over Llewdor, a small fishing community.

Early in the adventure, Manannan announces that he intends to take a trip. This provides you as Gwydion with your chance to learn Manannan's spells, escape from the house which has been your prison for the past 18 years and lift the evil spell hanging over Llewdor.





"My office is dusty. Clean it at once!"

The game begins in Manannan's mountain-top retreat. The evil wizard has not yet departed and so you are expected to perform some menial chore such as cleaning his study or dusting the kitchen.

The inside of the house, like all the game's many locations, is portrayed in stunning detail: candles flicker in sconces attached to the walls and a mirror on a dressing table actually reflects whatever is placed before it. There is a great deal to see, although most things remain tantalisingly out of reach until after Manannan has started his journey. Before he does you must play at being his abject servant.

Attempting to learn the secret of Manannan's magic or simply just neglecting your duties can result in humorous, if often tragic, consequences. If you are caught trying to learn spells, Manannan 'zaps' you with a well-aimed bolt of lightning from his finger, reducing you to a pile of dust.

The punishment for the second offence is a session of exercises. Gwydion is forced to perform a series of sit-ups, press-ups, star jumps and twists with greater alacrity than Jane Fonda.

Boredom is the arcade adventure's greatest enemy. Where text adventures allow the player to move quickly on from locations where nothing much happens, King's Quest III requires the player to guide Gwydion across the full width of the screen before the program will load the next scene, a process which takes several seconds and seems increasingly long as the game progresses. A facility for speeding up Gwydion's movement is included in the program, but even so, some scenes are tortuously long in comparison with their text-based counterparts.

As well as a great deal of patience, King's Quest III also demands a degree of proficiency with a joystick. When Gwydion leaves Manannan's house, if possible having collected several of the ingredients necessary for some of the wizard's spells, he must be guided along a winding path flanked on either side by a steep drop. One wrong move sends Gwydion to a painful death.

Mastering Manannan's magic is of prime importance if you are to defeat the evil wizard and liberate Llewdor. There are seven spells to be learned, including ones for causing deep sleep, making Gwydion fly like an eagle or a fly, and for brewing a storm. Each spell is cast using a potion made up from ingredients scattered throughout the wizened wizard's house and Llewdor. To make a potion, you simply mix the correct ingredients following instructions outlined in a small booklet packaged with the program.

If you are willing to put up with the breaks between scenes, King's Quest III provides a fresh and distinctly different kind of adventure. Most of the locations are beautifully drawn and well worth the wait. My favourite scene is one with a small cottage complete with smoke billowing from its chimney. If you tell Gwydion to open the front door and enter the house, he is quickly kicked out again by an irate bear. Some of the other locations include a small waterfall, skittering squirrels, flying seagulls and a nasty-looking Medusa.

King's Quest III is a refreshing break from normal run-of-the-mill text adventures. Despite its rather simple appearance, it is actually quite challenging and will baffle even experienced adventurers. If you are looking for something new, make sure King's Quest III is near the top of your list.

END

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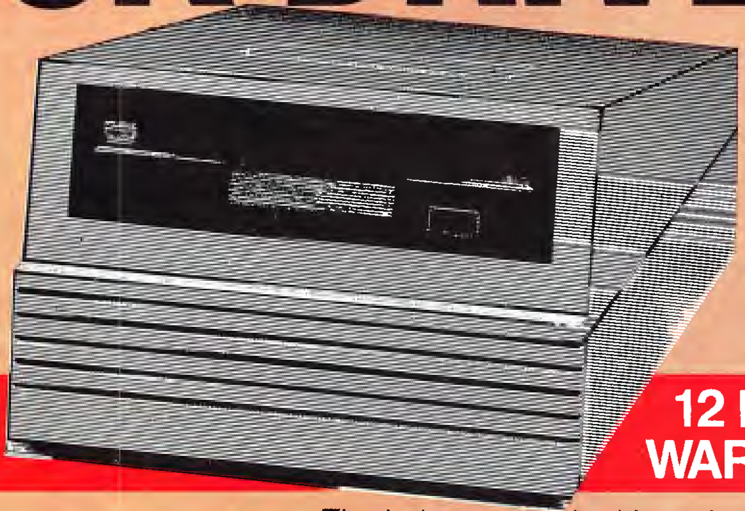

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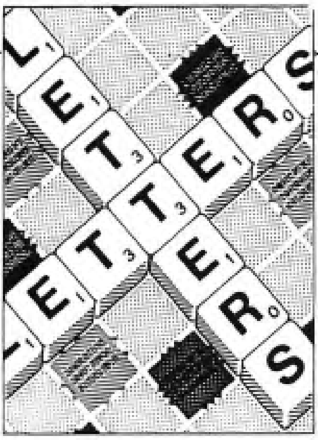

LETTERS

This is your chance to air your views — send your letters or contact us via Microtex on Telecom's Viatel, page 666. The address to write to us is Australian Personal Computer, 124 Castlereagh Street, Sydney 2000.

Pots calling kettles black

When you read the bleats and complaints in the press from software houses, composers and programmers about piracy and breach of copyright, have you ever thought just who it is making all the fuss? No? Then let me tell you that, by and large, it is the biggest bunch of rip-off merchants, thieves and plagiarists this mean old world possesses.

If this were a fair world, and copyright actually meant something, there would be only one spreadsheet, perhaps two word processors, one version of Pacman, an accounts program or two, a database, and a drawing program. What we have in fact is hundreds — indeed thousands — of such programs. Are all these the product of original thought?

We have windows and pull-down menus on every imaginable machine, not just Xerox, or, at best, the Apple Macintosh. We have clones (an upmarket euphemism for a blatant copy) which actually boasts of their ability to rip off everything IBM does.

In Silicon Valley and similar places around the world, some of the best brains spend their lives reverse-engineering other people's chips, while others tempt rival boffins with pots of gold to bring their secrets with them.

Meanwhile, who is said to be the villain of the piece? Why, none other than Joe Public, who has borrowed a copy of Donkey Kong for his son to use during the school holidays.

Apple had some difficulty in persuading a court that the 'look and feel' of a program should be protectable, but this is exactly what sets the Mona Lisa apart from the Laughing Cavalier. Nobody gives a damn what paint the artists used, or the type of brush. Equally, it is of no significance that one author uses a pencil and another a word processor — what is protected is this finished visible result, not the dictionary and thesaurus and ironmongery used to achieve it.

Okay, software houses; protect your programs as best you can, if you must. But don't dare adopt a holier-than-thou attitude unless you can prove that your programmer has never seen another program running.

D Kelsey

In an ideal world, everyone would be able to customise their programs to work exactly the way they want. How many times have you found a program that does 90 per cent of what you want? The remaining 10 per cent is usually promised 'for the next release' but never appears.

The human factor

I have just read yet another adulatory review of some 'latest' 80386 computers in an issue of *APC*, but still can't help wondering whether it is just another case of IBM-sponsored hot air baffling brains.

Is it really worth spending a lot of money on machines with no operating system? And is this really the way to provide users with the computers that they need, as opposed to the machines that the industry would like to sell.

If you mainly process

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words, my old-fashioned Amstrad PCW8512 with a substantial RAM disk is surely more than adequate (the RAM disk being something that none of these so-called 'modern' computers see fit to provide, I would like to emphasise).

For those who use their machines primarily for spreadsheets, or other mathematical purposes, an 8087 or 80287 floating-point coprocessor must be far more cost effective.

If high-resolution, multi-coloured graphics are your prime concern (as opposed to drawing pretty pictures to impress your boss), what is really needed *must* be a proper graphics coprocessor such as the Texas Instruments TMS34010 or the Transputer, together with an adequate supply of dedicated video RAM.

But why is it that the computer industry is always so desperate to point out how high its screen resolution and number of colours are, but so reluctant to mention the staggering cost of the high-quality colour monitor required to display them, not to mention the printer/plotter needed for hard copy.

Regarding the fantastic increase in processor speed, let us not forget that a computer system can only work as fast as its slowest component; and even if your typing is only one quarter as bad as mine, you know who that is, don't you?

And finally, printer manufacturers should stop raving about their almost unbelievable generosity in supplying a whopping great 3 whole K of buffer RAM when you can buy a 256k bit or 32k memory chip for around $10 retail.

So, I still think it's a load of bull, or have I missed something?

J Smart

Yes. Greed.

'Twittering' reveals sour grapes

Thank you for confirming it. *APC* staff don't have to buy the wares they twitter about, but I have to buy mine and I know I got value for money from my IBM Portable PC. Admittedly, I paid a bit less than the going rate for it, but it runs all my word-processing, accounting and spreadsheet packages just fine. I use Basic and C — both fine.

What is Guy Kewney twittering about? Why is Owen Linderholm feeling miffed ('Newsprint', *APC* September). Bill Gates puts his money where his mouth is. He makes a business judgment *not* to go for real-mode multi-tasking with MS-DOS. After all, like it or not, he *is* the world expert on MS-DOS and it *is* his money. If Owen is so convinced that the technique is profitable, he should stop twittering, put his own money on the line and market it. End of story.

But seriously, folks, I love your magazine — especially the advertisements.

J McVey

Microsoft obviously considers DESQView 386 a serious challenge, as it has done a detailed comparison of that product with its own Windows 386.

Windows catch

I was very disappointed with the depth of your reply to a letter from R Smith concerning Microsoft Windows (*APC*, October).

Mr Smith stated that he required to run a word processor, communications package, database and spreadsheet together and switch between them. He was under the impression, however, that 'no decent' application was available under Windows, and you said nothing to put him right!

I am sure that you must be aware that dBase III Plus will run in a window, and that Windows comes with built-in comms and word-processing software. This only leaves two problems to be resolved: that of a suitable spreadsheet; and the amount of memory required to run all these applications at once.

Mr Smith probably already uses Lotus 1-2-3. It is possible to run this *under* windows, but not *in* a window. Other windows applications are still in memory when Lotus is running, but to access them you have to press the ALT-TAB key combination. Pressing these two keys together will cause Lotus to be suspended and appear as an icon. Upon your return to Lotus, you will find yourself in the exact place you left it.

As both Lotus and Windows are memory grabbers, to run all the things Mr Smith wants at once will require some extended memory (about 1Mbyte at a guess).

D Austin

Microsoft Excel will certainly attract more users for Windows. And Palantis, a UK company, has released some Windows-based products which include a proper comms program, although we are unaware of an Australian distributor.

The travelling salesman problem

APC has received a number of replies to the request for a solution to the problem of a salesman visiting a number of towns while covering the least distance.

Linear programming of the type required to solve the 'travelling salesman'

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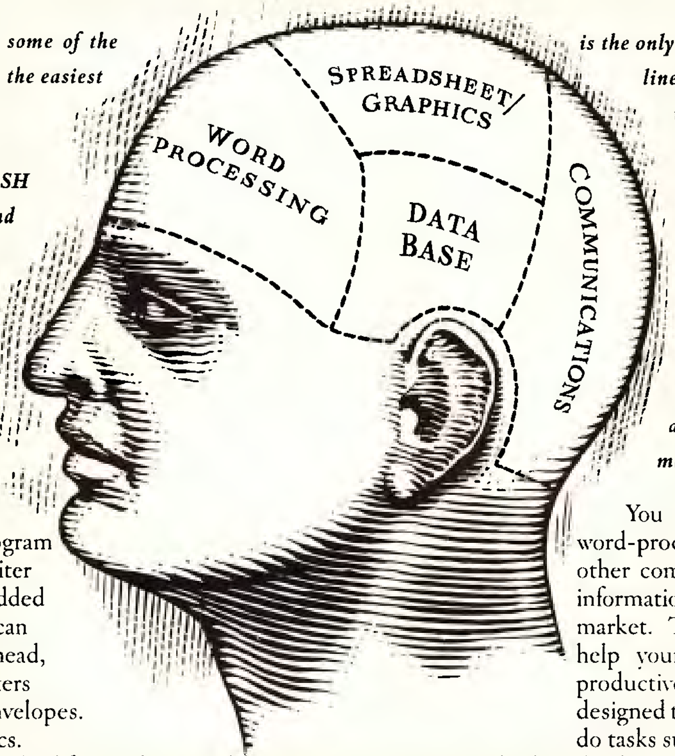
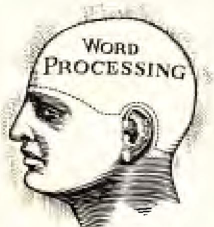
Anyone can learn to use Works. Microsoft, the leaders in software technology, have made sure of that. You see, Works is the only software of its kind to give you on-line help when you need it. It also comes with a complete set of lessons, so you can learn at your own pace. So even if you've never used a computer before, you'll become productive immediately. Works actually allows you to do the things you couldn't on individual software.

You don't have to close one file to work with another, which means all your programs can share information quickly and easily.



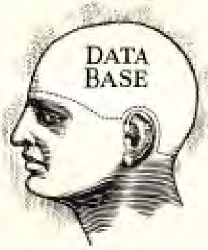


The word-processing program is your typewriter – with many added bonuses. You can create a letterhead, make form letters and address envelopes. You can even mix text and graphics.

Everything is designed to make life easier for you, including the special formats for printing mailing labels. Works handles headers, footers and page numbers automatically.

The word-processing program will give you the highest quality results possible for a printed word processing document.

It's also very fast. Which means you will be very productive.



The Works data base is your filing cabinet – with a difference. It finds what you want, sorts it, even calculates it. Names, addresses, product descriptions, dates, times and prices can all be stored in the data base.

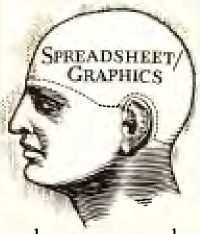
This program has a reporting component, which lets you print out information from your data base according to the characteristics you specify.

You may, for example, want a report on items which sold the best in a particular area. Works will automatically calculate totals and averages.

Pre-defined format fields on the data base program will save you time, by eliminating set-up time.

The program's extensive search criteria lets you quickly find any information you may need.

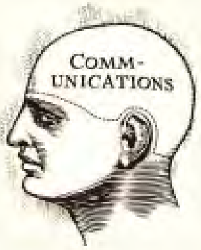
The spreadsheet program is your standard row-and-column accounting pad. With much more.



It allows you to work out budgets, financial forecasts, balance statements and more. It doesn't simply do the necessary calculations – it also recalculates whenever you change a number.

The spreadsheets are easy to work with and there's plenty of room to handle almost any set of numbers. You can split the screen to see different parts of a large spreadsheet at the same time. There's also a full range of pre-defined functions to make your complex financial, mathematical and statistical analyses go quickly.

There's also a charting component, so you can turn the numbers on your spreadsheet into charts. If you change the spreadsheet data, the chart instantly reflects those changes.



The communications program is your telephone and fax machine.

When you use your computer with a modem, Microsoft Works allows you to send and receive important data anywhere there's a phone line.

You can send your spreadsheet, word-processor or data base files to other computers. You can hook up with information services such as the stock market. Together, these programs will help your business run smoothly and productively. Because the tools are designed to work closely together, you can do tasks such as merge addresses from the database into a form letter, and insert spreadsheet numbers and charts into a business report.

Macros are another important time-saving feature. You can automate long chains of commands with a single keystroke taking the place of many.

Microsoft Works can also share information with other Microsoft programs. So you can begin with Works, then move up to any other Microsoft program if your needs become more demanding.

To find out more about how Microsoft Works would help you and your business, call Microsoft now on (02) 452 5088 or toll-free on 008 226 850. They'd be more than happy to help – after all, when you're the leaders in software technology, you've got a lot to say.

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problem can be handled by the Simplex method devised by George B Danzig in 1947. However, this method is limited in the size of problem it can handle. Simplex methods operate in exponential time, whereas the Karmarker Algorithm developed at AT&T's Bell Labs in 1984 words in polynomial time. This means it can deal with much larger problems such as those encountered in communications networks.

DAA Fagandini

There is a reference to the travelling salesman problem in Nils Nilsson's 1971 book, *Problem Solving in Artificial Intelligence.* On page 27 he notes that *'several efficient solution methods have been devised that are feasible for 50 or so cities. Approximate methods give good solutions (although not necessarily minimal mileage ones) for as many as 200 cities.'*

J S Matheson

The Soviet mathematician your correspondent is referring to is LG Khachian. In 1979 he solved a long-standing open problem in theoretical computer science. Although the average so-called linear programming problem can be solved efficiently, it wasn't known whether this *is* true generally. Khachian proved that this *is* the case.

In reality, the algorithm is of theoretical interest only because, on practical problems, it runs much more slowly than the Simplex algorithm. Even if Khachian's algorithm were efficient, it would not solve the travelling salesman problem which requires linear programming methods to produce not arbitrary, but integer, solutions.

R Gerth

There is now available in Australia, software for the IBM PC called Traveller which solves the travelling salesman problem by:

- Finding routes on transportation networks for each salesman or driver
- Finding the shortest route between any two points
- Computing minimum times and distances between all points
- Sequences stops on a route (the travelling salesman problem)

Traveller works out the best route for a rep or driver to take, showing travelling times and shortest and most time-effective distances between calls.

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Uncompromising style

The article, 'Importance of Style', which appeared in *APC,* September by Mark Burgess, was excellent.

Business may query the need for such standards, but the evidence is overwhelming that the maintenance burdens faced by many DP departments today are the direct result of the lack of disciplined adoption of such standards yesterday. The PC arena, no less than the mainframe and minicomputers, (maybe even more so) requires the level of professionalism that is implicit in standards of this nature.

As an aside, I have long held the belief that the advent of Basic, as the entry-level language of most widespread usage, has been responsible for the engendering of some particularly deplorable programming habits. Hopefully, the recent trend towards a structured Basic language will help to turn the tide.

R Stewart

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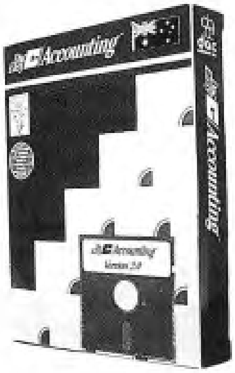

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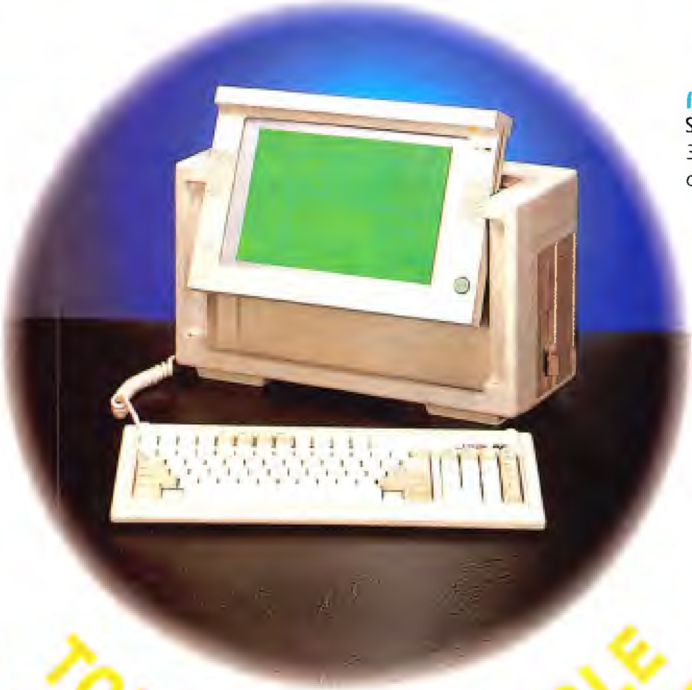

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TJ'S WORKSHOP

APC's monthly pot-pourri of hardware and software productivity tips. APC will pay between $100 and $200 for each tip published. Write to TJ's Workshop, APC, 124 Castlereagh Street, Sydney 2000.

Print range width

While TJ's has run several submissions on how to find the width of a 1-2-3 print range, they generally leave a bunch of @@cell('width') formulae lying around the spreadsheet. The macro in Fig 1 lets you move quickly from column to column of your print range, while a running total of the range width appears in the mode indicator in the upper right-hand corner of the screen.

Start with the cursor at the leftmost column of the print range. Hit Alt-W. Then hit Enter repeatedly to move the cursor one column to the right and increment the print range width. Hit Ctrl-Break with the cursor on the last column of the print range. The total width of the range will appear in the mode indicator. Be sure to give the range names in the left-hand column to the cells to their right.

R Schindler

This is the first macro I've seen that uses the mode indicator to display calculations. It is a very clever technique that works because of the formula in the third line of the macro. It uses the label in INSTRING as a template, into which it inserts a string conversion of the value stored in TEMP. That value is the accumulated widths of all the columns the user moves the cursor through by hitting Enter. The addition of these widths takes place at LOOP, which increments TEMP by the width of the new column. You can use the same template technique to display all kinds of interesting information.

The {onerror} at the beginning of the macro anticipates a Ctrl-Break rather than a more conventional error. Ctrl-Break, like an error, makes macro execution branch to the specified location, in this case, ERROR. ERROR is a one-line routine that cleans up after the macro by restoring the mode indicator to its normal status and erasing the accumulated value in TEMP.

```
\W          {onerror ERROR}~
LOOP        {let TEMP,TEMP+@cellpointer("width")}~  Increment width.
            {indicate   0   }                        See formula below.
            press enter for next column              These prompt lines
            control-break to stop   WIDTH  ===>       are not necessary.
            {?}{esc}~{right}/xgLOOP~                 Move right, loop.
ERROR       {indicate}/reTEMP~/xq                    Clean up.
INSTRING    {indicate       }                        Indicate template.
TEMP                                                 Width accumulator.

            Formula in third line of macro:

            @replace(INSTRING,12,0,@string(TEMP,0)) .
```

Fig 1 A 1-2-3 macro that displays the width of a print range in the mode indicator

The fourth and fifth lines of the macro appear in the control panel when you run the macro and every time you hit Enter to add a column. They act as a prompt and also tell you that the print range width is displayed to the right. Since it takes the macro processor a little time to type these characters into the control panel, they do slow the macro down. If you eliminate them, you won't have a prompt, but you'll have a quicker macro — JT.

The dating game

I have been using 1-2-3 ever since it was released and have always been infuriated by the way Lotus makes you enter dates. Over the years I more or less got used to it. However, I now supervise people who must work with both PCs and a mainframe, and I got tired of having to explain to them that dates are entered MMDDYY on the mainframe and @date (YY,MM,DD) on the PC.

The macro in Fig 2 solves the problem by letting you enter a date as MMDDYY with no commas or slashes. Just put the cursor on the cell where the date should be and type it in. The names in the leftmost column of the macro are the range names for the cells to their right. The range name DATES includes three cells: MONTH, DAY, and YEAR. These cells contain

```
\D          {GETLABEL ENTER DATE [MMDDYY] [0 TO QUIT] > ,DATESTR}
            {if DATESTR="0"}~{quit}
            {recalc DATES}@date(YEAR,MONTH,DAY)~
            {edit}{calc}~

MONTH             11    <===    @value(@mid(DATESTR,0,2))
DAY                3    <===    @value(@mid(DATESTR,2,2))
YEAR              87    <===    @value(@mid(DATESTR,4,2))
DATESTR     110387


            03-Nov-87           Range name DATES is the three cells
                                MONTH, DAY, and YEAR.
```

Fig 2 A macro that lets you enter dates in the form MMDDYY

the formulae to their right. If you add a line like {down}{branch \D} to the end of the macro, you can make it loop for continued date entry.

Having to write macros like this is a lot of trouble, but it will have to do until Lotus wakes up and gives us a better date format.

B Trickey

People have been complaining about the Lotus date format since the day 1-2-3 was released. I wonder if Lotus will change it in Release 3.0, or stick to its odd convention in the name of compatibility.

The only change I would make to Mr Trickey's macro is to add a second line that gives a date format to the current cell.

A simpler solution, but one that doesn't result in complete micro-mainframe compatibility, is the macro below

```
\D        /rfd1~@date(87,{?})~
          {down}{branch \d}
```

It date-formats the current cell and then enters most of the @date function for you. You do have to enter the month and day, separated by commas, but at least you can forget about the @ character, parentheses, and year. As an added bonus, you can rewrite it with the /xg command to make it work in Release 1A — JT.

Driving range

To determine the highest installed drive on your PC, the GETLAST.SCR script in Fig 3 will create GETLAST.COM, which returns the last valid drive as a DOS ERRORLEVEL. Create GETLAST.SCR with a pure-ASCII word processor or the DOS COPY CON command. Hit the Enter key after each line, especially the last one (with the Q) — and be sure to leave a blank line above RCX. Then put the script file on the same disk as DEBUG (Version 2.0 or later) and type

DEBUG > GETLAST.SCR

```
N GETLAST.COM
A
MOV AH,19    ;get current drive service
INT 21       ;call DOS to do it
MOV BL,AL    ;save current drive in BL
MOV DL,AL    ;and in DL too
INC DL       ;attempt to set next higher
MOV AH,0E    ;set drive service
INT 21       ;call DOS to do it
MOV AH,19    ;now get the drive again
INT 21
CMP AL,DL    ;did it take?
JNZ 118      ;no, restore drive and exit
JMP 108      ;yes, keep trying
MOV CL,AL    ;save last valid drive in CL
MOV DL,BL    ;now specify original drive
MOV AH,0E    ;set it back again
INT 21       ;call DOS
MOV AL,CL    ;get last valid drive again
MOV AH,4C    ;exit with it as ERRORLEVEL
INT 21

RCX
26
W
Q
```

Fig 3 GETLAST.SCR script to create GETLAST.COM, which returns the last valid drive as a DOS ERRORLEVEL. Create it with a pure ASCII word processor or the DOS COPY CON command. Hit the Enter key after each line, especially the last one (with the Q) — and leave a blank line above RCX. Then put GETLAST.SCR on the same disk as DEBUG.COM (2.0 or later) and type DEBUG < GETLAST.SCR. Running GETLAST.COM by itself won't do anything (although it won't hurt anything either). To put it to work and have it report your last consecutive drive, create and run the short GL.BAT batch file in Fig 4

It begins by first saving the current drive, and then attempting to make successively higher drive letters the default. Since DOS does not indicate an error when a program attempts to set an invalid drive, the only way to tell if it really worked is to ask for the current drive again. Once GETLAST has determined the last drive, it restores the original drive, and then uses DOS function 4Ch to exit with ERRORLEVEL holding the result.

Since ERRORLEVEL will be set to 0 if it's drive A:, 1 if it's B:, etc, any batch file can easily test which drive is last, as shown in the GL.BAT batch file in Fig 4.

E Winer

This will indeed report the last consecutive drive. If you're using four drives (A: through D:) and you issue the DOS 3.1 or later command

SUBST E: \DOS

GL will find and report all five drives. But if you leave a gap, and instead of typing the above command, type

SUBST F: \DOS

GL will stop when it reaches the first 'invalid' drive and report only four — JT.

Clockwork

A friend recently asked for an easy way to execute a specific program on the PC at boot-up on a specific day. The idea was to run CHKDSK.COM once each week and Norton's DISKTEST.EXE once each month to monitor the condition of a fixed drive.

The DATECHEK.COM program (which is generated by the DATECHEK.SCR DEBUG script in Fig 5 and the CHKDATE.BAT batch file in Fig 6 demonstrate just how simple this process is.

Type in the DATECHEK.SCR script using either a pure-ASCII word processor or the DOS COPY CON command (omitting the semicolons and the text following them). Hit the

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Enter key after each line, especially the last one (with the Q), and be sure that you leave a blank line above RCX.

Put this and DEBUG.COM (Version 2.0 or later) on the same directory and then type

DEBUG < DATECHEK.SCR

The program requests the system date via function 2AH, looks for the day of the week and, if it is Tuesday, then checks to see if it is the first Tuesday of the month. The program terminates with function 4CH, which returns a value in AL that the IF ERRORLEVEL command can test in a batch file.

You can alter the day of the week to be tested by changing the

CMP AL, 02

line in the listing (00 = Sun, 02 = Tues, 06 = Sat). The day of the month is reported in DL. Tuesday was chosen to avoid missing the monthly test due to a holiday (January 1 presents problems only infrequently).

CHKDATE.BAT uses the ERRORLEVEL returned by DATECHEK.COM to branch to the appropriate test. It's a dummy file for demonstration purposes; substitute your own commands for the 'ECHO It's Tues (not the 1st)', etc, messages shown in the example.

P R McClintock

```
ECHO OFF
GETLAST
ECHO VALID DRIVES:
ECHO A
IF ERRORLEVEL 1 ECHO B
IF ERRORLEVEL 2 ECHO C
IF ERRORLEVEL 3 ECHO D
IF ERRORLEVEL 4 ECHO E
IF ERRORLEVEL 5 ECHO F
```

Fig 4 Sample GL.BAT batch file to demonstrate GETLAST.COM, which returns the last valid drive as a DOS ERRORLEVEL. This example will scan your system and figure out the last continuous drive, but as shown it will stop at drive F:. Add more tests if you want to go higher

Fullpaint

Here's a handy tip not found in the FullPaint documentation for the Mac. If you press the COMMAND, OPTION, and T keys at the same time only the Patterns palette disappears. The Tools palette remains. This can be very useful if you constantly switch tools, but never change the selected pattern. The extra space is nice to have. To get the Patterns palette back, simply press COMMAND-OPTION-T again.

M Pinkerton

Red Ryder 10.0

Here's how to convert your old Red Ryder 9.4 procedures into Red Ryder 10.0 procedures — a detail that was unfortunately left out of the new manual.

1. Go back to Red Ryder 9.4 for a last time. While there, use the option in the Service menu to convert all of your procedures to TEXT files. Save each of them (use a DA word processor like miniWriter to make this easier).

2. Some of the procedure commands have been changed (for the better), so you have to edit the text files a bit. The new commands are documented on

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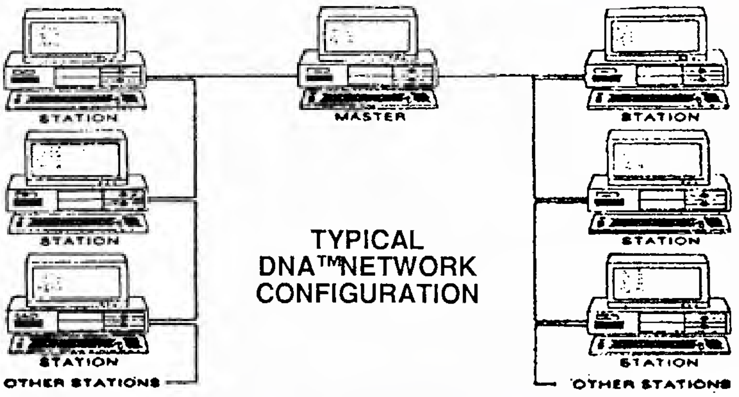

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Compatibility:	
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pages 72 to 82 of the *new* manual. For example, String Variables are now A$, B$, etc. and Numeric Variables are A%, B%, etc. And Label definitions for JUMPTO are different so you have to add ':' before the labels.

3. One super new ability of Red Ryder 10.0 is the ability to syntax check procedures before they're compiled. Do that now on your text files. Select CHECK PROCEDURE FOR SYNTAX . . . for each file. This step is very fast.

4. Finally select COMPILE TEXT FILE TO PROCEDURE . . . from the Service menu for each text file. The program adds a .PROC to the name of the file it creates so that you can tell the procedure file from the text file. That's important to know when setting up your new macros.

R M Kriss

Key Caps DA

My Mac is nearly four years old and twice recently suffered partial keyboard failures. Two of the keys just stopped functioning. If you're in the middle of a letter or document and something similar happens to you, simply go to the Key Caps DA. Click the mouse on the inoperative key and that letter, number, or symbol will be shown in the text area at the top of the DA. Simply copy it from there and paste it where needed.

Another option, which works in any program that has a global search and replace feature is to use a symbol that you ordinarily don't use in place of whatever the keyboard won't produce throughout the document. When you're done, use the Change command under the Search menu to have the program substitute the correct letter (or whatever) for the symbol. Paste the correct letter from the Key Caps DA straight to the Change To area of the Change dialog.

G Walker

HyperCard

If you have ever tried to paste a text file from a DA like miniWriter or MockWrite into HyperCard (in what seems like a perfectly natural way to bring in previously written text), you've discovered that you have to close the DA after copying the material from it, before HyperCard will allow you to paste.

Rather than spending all your time opening and closing DAs, launch Switcher, and open HyperCard from within Switcher. Open your text handling DA on the Switcher screen. Now you can switch back and forth between the DA and HyperCard, easily cutting and pasting.

This works on Mac Pluses and SEs with as little as 1Mbyte of memory, as long as you don't try to open any other applications with Switcher.

B Long

```
N DATECHEK.COM
A
MOV AH,2A     ; Get date
INT 21
CMP AL,02     ; Is it Tues?
JNZ 0113      ; No, AL=2
MOV AL,00     ; Yes, AL=0
CMP DL,08     ; First week?
JNB 0115      ; No, AL=0
MOV AL,01     ; Yes, AL=1
JMP 0115
MOV AL,02     ; Set level
MOV AH,4C     ; Terminate
INT 21

RCX
19
W
Q
```

Fig 5 DATECHEK.SCR script to create DATECHEK.COM. This checks for Tuesday; for another day, change the CMP AL,02 line (0=Sun, 1=Mon, 2=Tues, etc). Type this in using a pure ASCII word processor or the DOS COPY CON command (omit the semicolons and the text following them). Hit Enter after each line, especially the last one (with the Q), and be sure to leave a blank line above RCX. Put this and DEBUG.COM (Version 2.0 or later) on the same directory and type DEBUG<DATECHEK.SCR

- If you want to return to the Finder rather than to HyperCard when quitting applications or documents launched from HyperCard, hold down the Option key while quitting.

B Jastram

- Often when creating a new stack you'll want to use the same buttons on different cards, with different backgrounds. If you save these buttons in the Scrapbook, you lose all identifying information, and can easily forget which button is which.

The solution is to create a 'ScrapCard' on which to save these buttons. First, add a new card at the end of the stack. Paste any button you in-

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tend to use again onto this card. Now all you need to do is press COMMAND-4 to get to the ScrapCard (be sure to leave it as the last card in the stack), choose and copy the appropriate button, press COMMAND ~ to return to the card you were working on, and paste the button in.
N Guadagno

- The HyperCard User Manual falls somewhat short of explaining all of HyperCard. For a more complete description of the program's functions and capabilities, select HELP from the Home Card and then select PRINT STACK from the File menu.

Printing in the quarter-size mode will give you eight cards on a standard 8.5 x 11in sheet. You'll wind up with a 52-page reference copy of the Help stack, which will include details of the HyperTalk programming language. That material is only available in a printed form from APDA (Apple Programmers' and Developers' Association) or Danny Goodman's, *The Complete HyperCard Handbook.*
J P Patterson

Mac parameter RAM

The parameter RAM (PRAM) is where the Mac stores basic information like the time and default font (and lots of other things) that it must know when you start it up. It's powered by the battery. And occasionally it gets fouled up and must be reset.

On Macs and Mac Pluses resetting the PRAM is simple. Just shut the machine off and remove the battery for 5 or 10 minutes. It's impossible to do that on the SE or the II, however. But Apple has provided another way to reset the PRAM. You must be using Control Panel 3.1 (or higher). Version 3.1 is included with System 4.1 and Finder 5.5.

```
ECHO OFF
DATECHEK
IF ERRORLEVEL 2 GOTO 2
IF ERRORLEVEL 1 GOTO 1
ECHO It's Tues (not the 1st)
GOTO END
:2
ECHO It's not Tuesday
GOTO END
:1
ECHO It's the first Tuesday
:END
```

Fig 6 Demonstration CHKDATE.BAT batch file that uses IF ERRORLEVEL to test the return code generated by DATECHEK.COM. Substitute your own commands for the ECHO messages shown

Here's what to do: as you select the Control Panel hold down the Shift, Option, and Command keys. You'll get a dialog box asking if you want to zap (reset) the parameter RAM. Select YES, and then RESTART your Mac.

This will set most of the PRAM to zero, but will not reset the clock. Reset all your other options as they were or as you wish.
J Van Arkel

Mac Excel

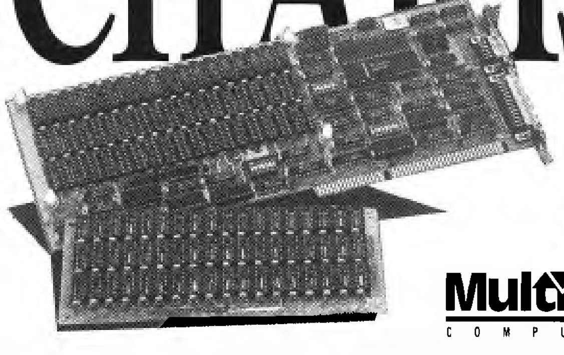
To make a large spreadsheet fit on a single page (for presentation and to make photocopying easier), increase the font size to 16 point for the whole sheet. Then print using 50 per cent reduction. If the size is still too big you can increase the font size further and use an even greater reduction. Use the Preview Print function to see if your results fit on a single sheet.
R J Montgomery

- Here's a faster and easier way to insert rows and columns. Mouse to the edge of the sheet where you want to insert the rows or columns and hold down the Option key as you click the mouse.
B J Lutz

SuperPaint

If you need laser printed screen dumps at smaller than actual size, SuperPaint is the perfect tool. First, using SuperPaint, open the MacPaint file containing the dump (remember that Command-Shift-3 saves the current screen to the desktop as a MacPaint file) and clean it up or modify it as you wish. Then select either all of it or the region you want to print and choose COPY TO DRAWING (Command E) from the Edit menu. To scale your dump, now use the Scale Selection command (make sure you do this in the Draw layer). For a LaserWriter use a multiple of 24 per cent: 24, 48, 72 or 96 per cent, depending on the final size required.

The image won't look too good on the screen, but will print very nicely. SuperPaint's Draw layer can also be



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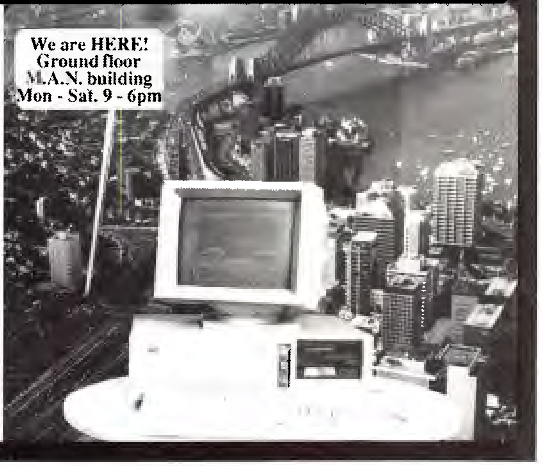

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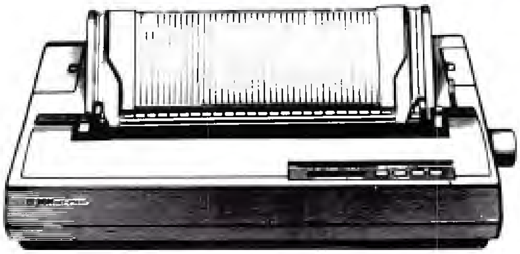

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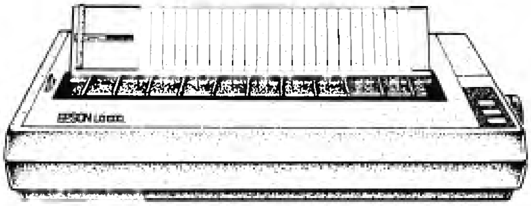

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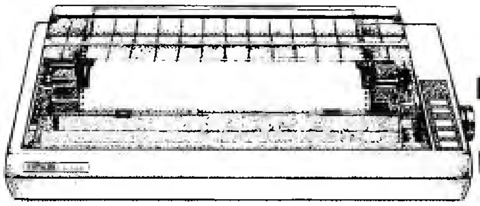

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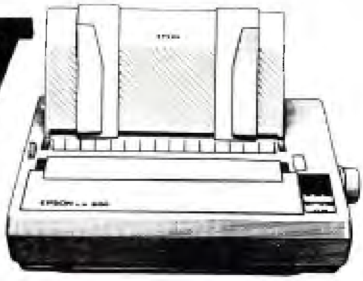
Large 136 column; fast 240 cps; 9-pin dot matrix.



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used to put captions that will print in laser-quality fonts under screen dumps.
K Shay

Non-blinking cursor

Microsoft Word's graphics mode is painfully slow on 8088-based computers. The text mode is faster, but the blinking mouse cursor is too distracting for extended use. Here is a patch for Word 3.1 that keeps the mouse cursor from blinking in text mode.

Starting with DEBUG and a backup working copy of WORD.COM, Version 3.1, enter the lines below, ending each with a carriage return and putting the single space shown between the 90s.

```
DEBUG WORD.COM
e 29E6
90 90 90 90 90
w
q
```

This patched version of WORD.COM will give you the speed of Word's text mode, but with a solid, non-blinking cursor on-screen.
C Miller

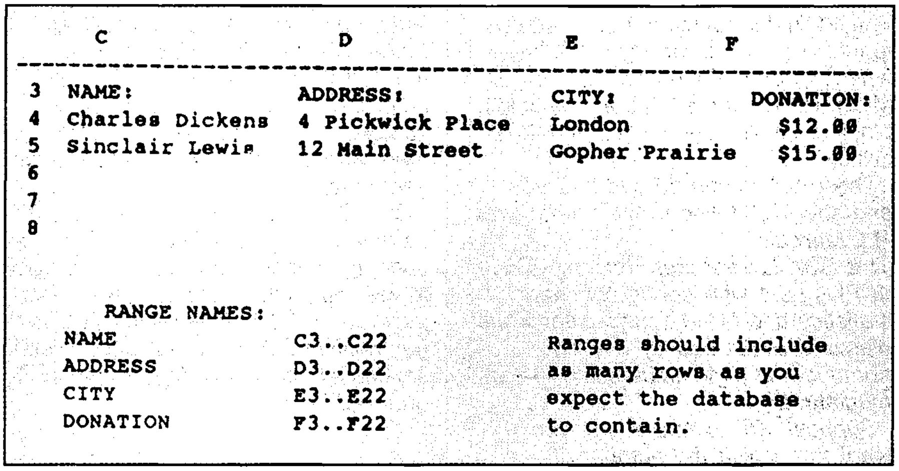
For those who can't stand blinking cursors, this is a program-saving patch. Before making it, however, it's a good idea to double-check exactly what you're changing, since many software houses make minor changes to programs without changing the release number. Before editing WORD.COM with the 'e 29E6' command, first do a search for the five bytes you want to change by issuing the command

```
S 0000 FFFF B8 0A 00 CD 33
```

DEBUG will respond with a memory address in the form xxxx:YYYY. Ignore the xxxx. Use the YYYY as the memory address for the e (enter) command in the second line of Mr Miller's procedure. My copy of Word 3.1 did match the 29E6 address that Miller gives. Word 3.0 gave an address of 2873. Entered at the correct address, the patch works for both versions.
-JT

Single-pass statistics

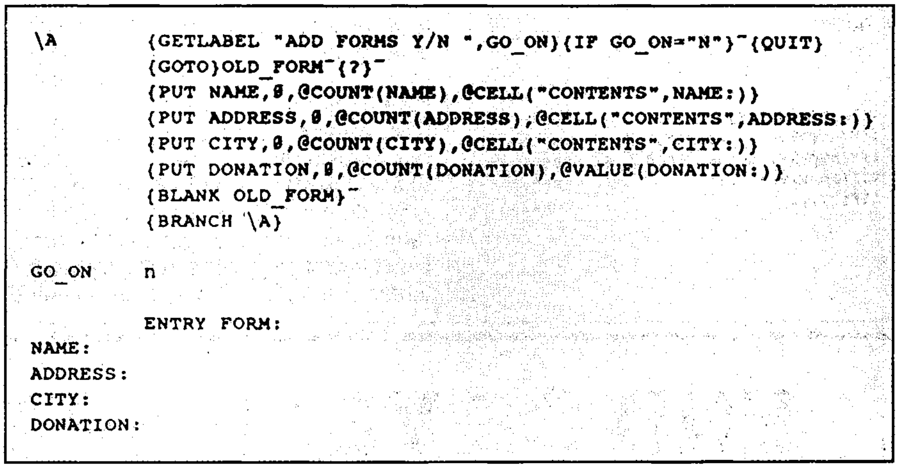
I often need to produce summary total and sub-total reports on the contents of character and/or date fields. The COUNT command in dBase III Plus requires you to pass the whole file to derive a single total, so if you need to know how many people responded 'Y', 'N' and '?' to a questionnaire, you have to COUNT the whole database three times. Then, of course, you must format this information for the report. If you're COUNTing sub-totals for 20-part numbers, it takes forever.



```
      C                    D                   E            F
-------------------------------------------------------------------
3  NAME:               ADDRESS:            CITY:          DONATION:
4  Charles Dickens     4 Pickwick Place    London            $12.00
5  Sinclair Lewis      12 Main Street      Gopher Prairie    $15.00
6
7
8


      RANGE NAMES:
   NAME                C3..C22             Ranges should include
   ADDRESS             D3..D22             as many rows as you
   CITY                E3..E22             expect the database
   DONATION            F3..F22             to contain.
```

Fig 7 The database that is built by the macro in Fig 8



```
\A        {GETLABEL "ADD FORMS Y/N ",GO_ON}{IF GO_ON="N"}~{QUIT}
          {GOTO}OLD_FORM~{?}~
          {PUT NAME,0,@COUNT(NAME),@CELL("CONTENTS",NAME:)}
          {PUT ADDRESS,0,@COUNT(ADDRESS),@CELL("CONTENTS",ADDRESS:)}
          {PUT CITY,0,@COUNT(CITY),@CELL("CONTENTS",CITY:)}
          {PUT DONATION,0,@COUNT(DONATION),@VALUE(DONATION:)}
          {BLANK OLD_FORM}~
          {BRANCH \A}

GO_ON     n

          ENTRY FORM:
NAME:
ADDRESS:
CITY:
DONATION:
```

Fig 8 A macro that simplifies entering 1-2-3 data records

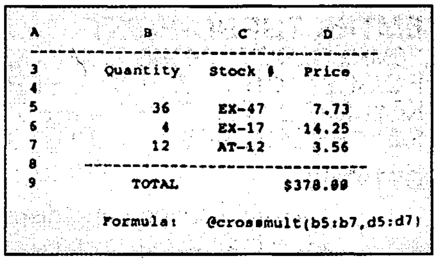
To get all these statistics in one file pass — and nicely formatted, besides — try this method. Start by indexing your file on the field you will be COUNTing. Then CREATE REPORT FORM *filename.* Answer Y to the 'Summary report only?' query in the Group/Sub-total screen. Finally, for the report's column, use the AT() function to convert the existence of a specific character into a numeral — 1 or 0 — and total on this field. For example, if you have a one-character field called Ans that is filled with either 'Y', 'N', '?' or nothing (no response), the Contents and Headings of your four columns would be

AT("Y",Ans)	**Yes**
AT("N",Ans)	**No**
AT("?",Ans)	**No Option**
AT(" ",Ans)	**No Response**

A one-character field can be tested and tallied for any value using this method. A larger character string can be tested by adding the SUBSTR() function.

The corresponding function to return a 1 if a date has been entered and a 0 if the date field is blank is

```
(MONTH(date_fld))**0
```



```
A            B           C          D
------------------------------------------
3        Quantity     Stock #     Price
4
5              36      EX-47       7.73
6               4      EX-17      14.25
7              12      AT-12       3.56
8        ---------------------------------
9           TOTAL               $378.00

         Formula:   @crossmult(b5:b7,d5:d7)
```

Fig 9 A Framework II spreadsheet that uses the user-defined function @crossmult

The MONTH() function returns an integer from 1 to 12 for any valid date, which, taken to the 0 power, is 1. MONTH() returns a 0 if the date field is blank or invalid, and this to the 0th is still 0.

These tallies can be sub-totalled and sub-subtotalled in the normal way.

R L Marcus

This is a flawless gem for any dBase III Plus user who needs summary statistics and Mr Marcus's clear white diamond works equally well on numeric and logic fields using the immediate IIF().

Suppose, for example, that you want to analyse the number of employees of your company's 2000 clients to get a better handle on who buys your product. The following Contents and Headings might reveal information:

```
IIF(emp<10,1,0)                Under 10
IIF(emp>9.AND.emp<100,1,0)     10-99
IIF(emp>99.AND.emp<1000,1,0)   100-999
IIF(emp>1000,1,0)              1000+
IIF(.T.,1,0)                   Total
```

Note the expression to get the total. Since .T. is definitely always True, IIF(.T.,1,0) effectively COUNTs each record. (In fact, as I later discovered, you could replace the last IIF statement with a numeral 1 and achieve the same result.)

For dBase II and III users who don't have the luxury of AT() and IFF() functions, try adding a special numeric field to your database, put a numeric 1 into every record, and total on this field to get multiple COUNTs — I've received several letters suggesting this technique — JT.

Easy data entry

Databases in 1-2-3 take the general form of the small database in Fig 7. Each record is in one row, and fields are the cells in the row. It's relatively easy to add records to this database, since there are not many fields, and they all fit on the screen.

For wider databases, however, it is much easier to use a data entry macro of the kind shown in Fig 8. All the labels in the leftmost column are the range names for the cells to their right. Don't forget the colons in the last four labels. The only unlabelled range name is OLD_FORM, which is the four cells, NAME:, ADDRESS:, CITY:, and DONATION:.

The macro begins by asking if you want to add new records. If you enter a Y, it sends the cursor to the first line in the entry form. You then enter the information you want to include in the new record. In this case, since there is only one {?} pause in line 2 of the macro, you should enter new information by hitting the Down Arrow.

If you prefer to enter each label with the Enter key, you could use a {?} pause for each field. When the new record is finished, hit Enter, and the {put} commands enter the data into the database. Note that the DONATION: field is numeric, and that the {put} command enters a value into the database. After each new record, the macro blanks the entry form and the range named GO_ON, and loops back to the initial prompt. When you are finished entering new records, type N at the prompt.

S Ulinski

I like the way the {put} statements work in this macro. They figure out how far down in the database to put each new record by doing an @count

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of the number of records already there.

However, I don't like having to answer the ADD FORMS Y/N prompt all the time. I'd leave that out completely and just get out of the loop with Ctrl-Break. If you think Ctrl-Break is inelegant, you can always put in a test for the data entered in the NAME: field. If it consisted, for example, of a single X, you could skip the {put} statements, blank OLDFORM, and quit.

Furthermore, the macro would be safer with a {?} pause for each field, with an optional {down} command to move the cursor to the next field. Otherwise, if you mistakenly hit Enter before you have entered the data for each field, you end up with a partial record in your database, which you have to fix — JT.

Cross multiplying

When you build spreadsheets on the PC, you often have to multiply a range of cells by another range. An example of this is shown in Fig 9, where the quantities in column B are multiplied by the prices in Column D to obtain a total value for an inventory or an invoice.

If you were using 1-2-3, you would have to multiply each quantity by each price and then add all three products. With Framework II, however, you can write a new @ function that allows you to multiply one range by another. This is the solution that is used in Fig 9. The formula for the TOTAL cell, D9, is reproduced below it as text.

In order to use the new function, which I have called @crossmult, just create a frame in your Library Cabinet and call it crossmult. Type in the FRED program in Fig 10. The lines that start with semicolons are comments that help other users understand this program, *and do not have to be typed.* Without them, the program is really quite short.

This feature in Framework that allows you to write custom @ functions makes it much more flexible than 1-2-3, in which it seems you always have to write macros in order to solve problems.

C Carroll

The ability to change the computing environment so easily is one of Framework's great strengths. There are several new spreadsheets to be released soon that will also permit you to design your own functions. Before much longer, this should be a standard feature of any self-respecting spreadsheet — JT.

Catalog tips

One feature of BASIC.SYSTEM/-ProDOS on the Apple II that I find quite useful, especially when I have a lot of files in a directory, is the ability to CATALOG the directory by file type. That is, you can tell the system to display only the names of files with a specified type. To do this, add the suffix ,Txxx to the normal CATALOG command, where xxx represents the standard 3-character mnemonic for the file type (BAS, DIR, AWP, TXT, etc), or the hexadecimal version of the file-type code number itself.

For example to list all Applesoft programs in the current directory, use the command CATALOG, TBAS. CATALOG can also be followed by a pathname or partial pathname, so you can catalog by file type in any directory without having to change the current prefix first.

Dr K Buchholz

AppleWorks shortcut

I'll bet most people don't know that you can return to the AppleWorks main menu from anywhere in the program in just two keystrokes: open-apple/Q followed by Esc. (Open-apple/Q is usually for switching between open files.) You can take advantage of this hint to simplify macro commands — no more multiple Esc tokens to guarantee a return to the main menu.

On a related point, if you're just about to print a document but you want to make a last-minute change, you can quickly return to the document with open-apple/Q followed by Return (the proper filename is always highlighted).

M Perry

AppleWorks in colour

If you have an ImageWriter II and AppleWorks, you can easily print text in colour. The key is to add a custom printer to your printer list and replace the Boldface Begin and End codes with ones that enable and disable colour printing. You use the standard codes for the other printing features.

Here is the one-time procedure for setting up the colour-printer driver:

1. Choose 'Other Activities' from the main menu and then choose 'Specify information about your printer(s)'.
2. Choose 'Add a printer (maximum of 3)' and then 'Custom printer', name the printer ImageColor (or whatever you like), and access it from slot 1.
3. The answers to the configuration questions should be as follows:

Needs line feed after each Return — No
Accepts top-of-page commands — Yes
Stop at end of each page — No
Platen width — 8.0 inches
Interface cards — Don't change if you're using a Super Serial Card, IIc, or IIGS port. For other interfaces, check your manual.

Printer codes:

5 chars./inch	Control-N
10 chars./inch	Control-O Esc N (that's "oh")
12 chars./inch	Esc E
15 chars./inch	Esc q
17 chars./inch	Esc Q
6 lines/inch	Esc A
8 lines/inch	Esc B
Boldface begin	Esc K

```
; create a local variable to put our working total in
@local (subtotal),
; loop through cells until there are no more
@while(
@get(@item1)<>#NULL!,
; make sure we got a legitimate number from both cells before
; multiplying them
@if(
@and(@isnumeric(@get(@item1)), @isnumeric(@get(@item2))),
subtotal := subtotal+@get(@item1)*@get(@item2)
    ),
; move to next cell in first row
@next(@item1),
; move to next cell in second row
@next(@item2)
        ),
; return the formula answer
@return(subtotal).
```

Fig 10 A Framework II program that creates a new @function called @crossmult

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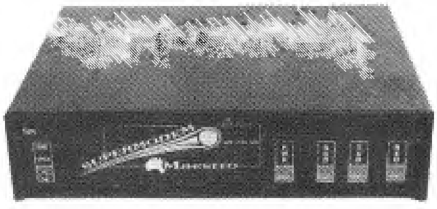

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Boldface end	Esc K0 (that's zero)
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Subscript end	Esc z Esc W
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Superscript end	Esc z Esc W
Underline begin	Esc X
Underline end	Esc Y

(Note: Select the option that says 'Printer has start/stop underline commands.)

Finally, escape back to the main menu, and you're finished.

```
*** PASSWORD.PRG
CLEAR
SET TALK OFF
SET CONS OFF
PRIV pass,p1,p2,p3,p4
pass="XXX "
@ 10,26 TO 12,50 DOUBLE
@ 11,29 SAY "ENTER PASSWORD: ___
@ 11,44 SAY " "
WAIT "" TO p1
@ 11,45 SAY "*"
WAIT "" TO p2
@ 11,46 SAY "*"
WAIT "" TO p3
@ 11,47 SAY "*"
WAIT "" TO p4
SET CONS ON
IF .NOT. UPPE(p1+p2+p3+p4)=pass
  SET ESCAPE OFF
  temp=0
  crook=" BAD PASSWORD--ACCESS DENIED! -
  DO WHIL temp<10
    ?? CHR(7)
    @ 14+temp,23 GET crook
    temp=temp+1
  ENDDO
  QUIT
ENDI
CLEA
RELE p1,p2,p3,p4,pass
* Password OK, enter program
RETURN
```

Fig 11 A rather subtle dBase password-protection program

When preparing your document, identify a passage to be printed in colour just as you would for boldfacing it: Press Control-B (a ^ will appear) and then type a one-digit colour code: 1=yellow, 2=red, 3=blue, 4=orange, 5=green, 6=purple. At the end of the coloured text type Control-B once again. When you print the document, specify that you want to print the file to the ImageColor printer.

Here is how two sample sentences appear with embedded colour codes:

This is:
^1G^^2R^^3E^^4A^^5T^^6!
^1Yellow^,^2Red^,^3Blue^,
^4Orange^,^5Green^,^6Purple^

When you have two non-black colours next to each other, you will have to boldface-end the first before beginning the next colour. That is why there are two carets between the letters in the word GREAT in the first example.

Also, the boldface-end for a colour should appear on the same line as the boldface-start. If it doesn't, you must place the colour-code digit at the beginning of each subsequent line, up to and including the line with the boldface-end which becomes inconvenient when you edit the document and paragraphs are reformatted.

T DeLuca

Avoid wasted disk space

When you save a short program to disk on top of a longer one, Apple's DOS 3.3 does not free up the sectors that the disk file is no longer using. To avoid this problem, always delete the file before saving the program.

R Koc

This same problem does not occur if you're using ProDOS 8 or ProDOS 16 — JT.

Password protection

Because dBase doesn't offer built-in password protection, we use PASSWORD.PRG (Fig 11) to limit access to our company's sensitive procedures and data. The problem with most passwords is that someone passing by might see the password as an authorised user types it in. Here we 'SET CONSOLE OFF' so the keystrokes never appear on the screen. Moreover, the format makes it appear that the password is only three characters long — in fact, it's four.

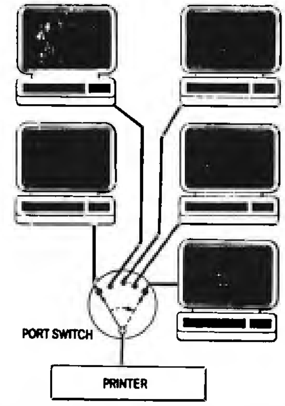
To prevent a more determined snooper from simply reading the program code and seeing the password, we run the finished programming through dBase III Plus's dBCODE utility, which encrypts the code and also makes it run faster.

T Chye Lee

Often the simplest solution is the best. Mr Lee's password code, 'XXX'+Spacebar [Now he'll have to change it — Ed], *is easy to remember and painless to enter, but the subtle touch of formatting the screen for three letters would cause an unauthorised user to wear his fingers out typing three-letter combinations (note that 'XXX'+<Enter> doesn't get It. Nice.*

In a more complex situation, different passwords could be used to provide higher levels of access. You might

PORT SWITCH



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prefer to give the user more than one chance to enter the correct password. And, if an unauthorised user attempts to enter your program, you might want to do more than simply QUIT.

Mr Lee's suggestion about dBCODE is worth heeding — it's easy to overlook this utility, which is included with dBLINKER on the dBase III Plus Utilities Disk. It's the simplest way to 'protect' valuable code. dBCODEd programs also execute faster because comment lines and indentations are removed for you. A major drawback of dBCODE, however, is that (like Clipper) it doesn't support many of the interactive commands, such as EDIT OR BROWSE — JT.

```
*** DOSPROM.PRG
@ 20,0 CLEA
doscom=CHR(255)
DO WHIL doscom>" "
  ?
  @ ROW(),3 SAY [Please enter a DOS command        <CR>=Xit]
  ACCE "C> " TO doscom
  IF doscom>" "
    RUN &doscom
  ENDI
ENDD
RETU
```

Fig 12 Simulating DOS from inside a dBase program

III Plus time bomb

After much hair-pulling and an anxious call to Ashton-Tate, I learned that the ON ERROR in dBase III Plus fails to trap some common problems, such as Error [56], 'Disk full when writing file: *filename*', and Error [52], 'No database in USE. Enter filename:'.

Error [56] is a time bomb. When it occurs, you can't CLOSE the file that was being written when the disk overflowed or USE it to see what it contains. The only choice is to QUIT, re-enter dBase, and recover what you can. The file you were writing has zero records.

Error [52] is less serious — you can trap it with

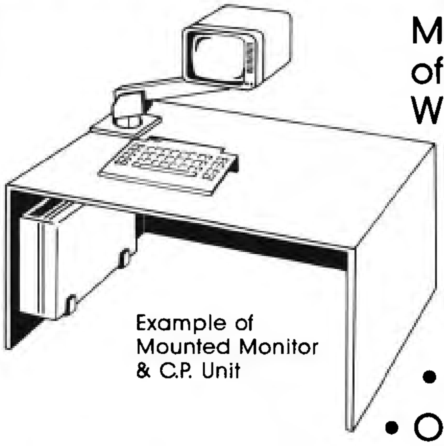
```
 IF CHR(0)=DBF()
          * do file select routine
 ENDIF
```

The DBF() function returns a null string if no database is in USE in the current work area. Note that this trap must precede the error; once a user attempts to access data in a closed area, Error [52] pops onto the screen.

D Nichols

Mr Nichols's letter highlights a dangerous situation in dBase III, Clipper and FoxBASE. According to Ashton-Tate, Errors [52] and [56] are the only 'true errors' that are not trapped by ON ERROR in dBase III Plus, Version 1.1. However, there is some additional fine print.

DO YOU NEED MORE DESKTOP SPACE...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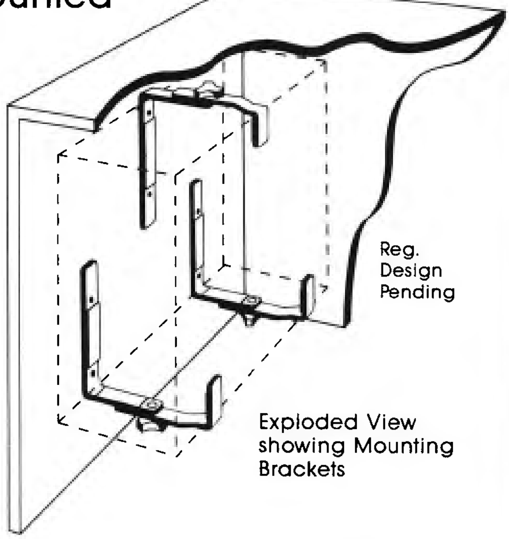
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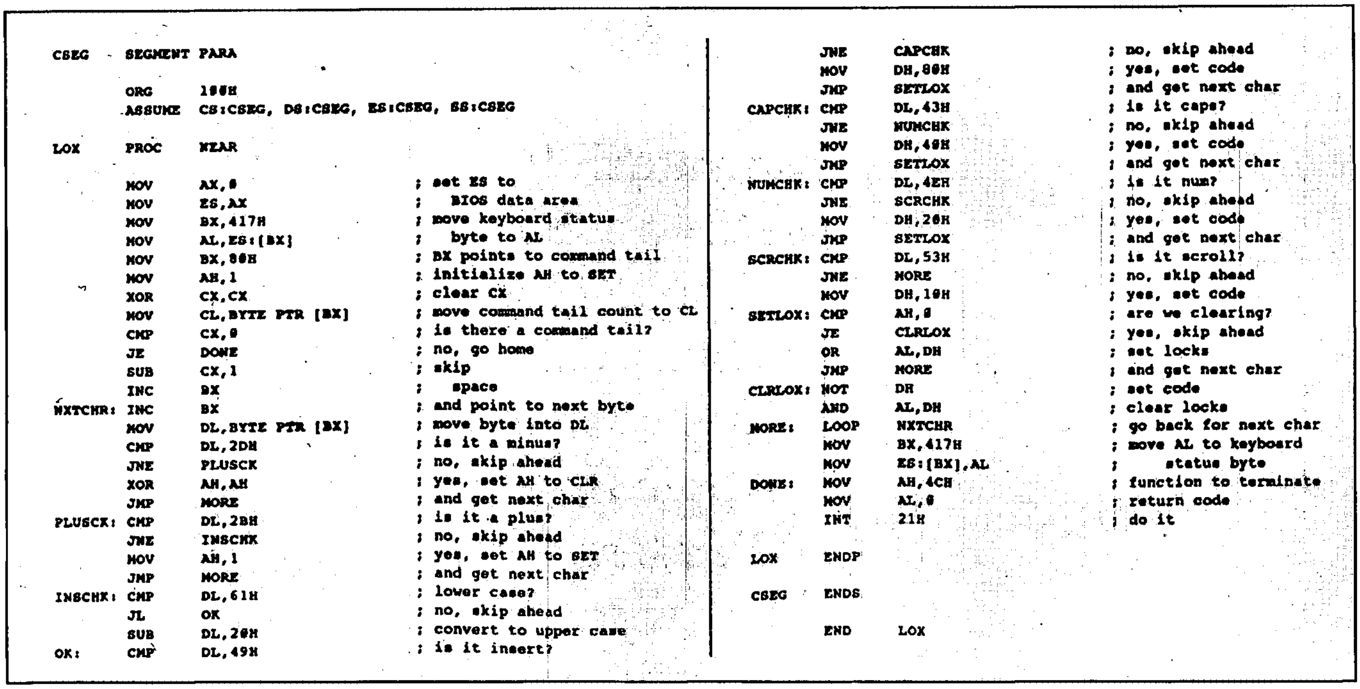

```
CSEG    SEGMENT PARA

        ORG     100H
        ASSUME  CS:CSEG, DS:CSEG, ES:CSEG, SS:CSEG

LOX     PROC    NEAR

        MOV     AX,0                    ; set ES to
        MOV     ES,AX                   ;   BIOS data area
        MOV     BX,417H                 ; move keyboard status
        MOV     AL,ES:[BX]              ;   byte to AL
        MOV     BX,80H                  ; BX points to command tail
        MOV     AH,1                    ; initialize AH to SET
        XOR     CX,CX                   ; clear CX
        MOV     CL,BYTE PTR [BX]        ; move command tail count to CL
        CMP     CX,0                    ; is there a command tail?
        JE      DONE                    ; no, go home
        SUB     CX,1                    ; skip
        INC     BX                      ;   space
NXTCHR: INC     BX                      ; and point to next byte
        MOV     DL,BYTE PTR [BX]        ; move byte into DL
        CMP     DL,2DH                  ; is it a minus?
        JNE     PLUSCK                  ; no, skip ahead
        XOR     AH,AH                   ; yes, set AH to CLR
        JMP     MORE                    ; and get next char
PLUSCK: CMP     DL,2BH                  ; is it a plus?
        JNE     INSCHK                  ; no, skip ahead
        MOV     AH,1                    ; yes, set AH to SET
        JMP     MORE                    ; and get next char
INSCHK: CMP     DL,61H                  ; lower case?
        JL      OK                      ; no, skip ahead
        SUB     DL,20H                  ; convert to upper case
OK:     CMP     DL,49H                  ; is it insert?
        JNE     CAPCHK                  ; no, skip ahead
        MOV     DH,80H                  ; yes, set code
        JMP     SETLOX                  ; and get next char
CAPCHK: CMP     DL,43H                  ; is it caps?
        JNE     NUMCHK                  ; no, skip ahead
        MOV     DH,40H                  ; yes, set code
        JMP     SETLOX                  ; and get next char
NUMCHK: CMP     DL,4EH                  ; is it num?
        JNE     SCRCHK                  ; no, skip ahead
        MOV     DH,20H                  ; yes, set code
        JMP     SETLOX                  ; and get next char
SCRCHK: CMP     DL,53H                  ; is it scroll?
        JNE     MORE                    ; no, skip ahead
        MOV     DH,10H                  ; yes, set code
SETLOX: CMP     AH,0                    ; are we clearing?
        JE      CLRLOX                  ; yes, skip ahead
        OR      AL,DH                   ; set locks
        JMP     MORE                    ; and get next char
CLRLOX: NOT     DH                      ; set code
        AND     AL,DH                   ; clear locks
MORE:   LOOP    NXTCHR                  ; go back for next char
        MOV     BX,417H                 ; move AL to keyboard
        MOV     ES:[BX],AL              ;      status byte
DONE:   MOV     AH,4CH                  ; function to terminate
        MOV     AL,0                    ; return code
        INT     21H                     ; do it

LOX     ENDP

CSEG    ENDS

        END     LOX
```

Fig 13 LOX.ASM code to create LOX.COM shift status controller. Syntax is LOX –/+ CNSI

Messages and questions like 'No Find' or 'filename already exists . . . overwrite (Y/N)' — which you might consider error messages — are classed as 'status messages' or 'safety messages', and they, too, will not be trapped by ON ERROR.

Other untrapped error messages are those issued from inside special functions, such as BROWSE or MODIFY REPORT. Furthermore, all error messages without a [###] next to them in the manual will go untrapped. This includes some disastrous conditions like 'Not enough disk space for sort'. Another pitfall occurs when the user attempts to access an empty floppy drive: DOS's 'Abort, Retry, Ignore' comes up and, of course, Abort crashes dBase without closing the files.

After calling Ashton-Tate, I put on my Sherlock Holmes cape and entered

```
ON ERROR ? "Elementary, my dear Wa
son."; +" It's Error "+STR(ERROR(),3)
```

I passed over the miscellaneous stuff: error messages relating to ASSIST, CATALOG/VIEW, importing .SYLK files, multi-users, dbRUN, and internal dBase errors like 'Damaged Index.' Still, it didn't take a magnifying glass to find more errors in Ashton-Tate's list of untrapped errors:

[39] Numeric overflow — data was lost

[89] Cannot erase open file

Frankly, I think that Ashton-Tate should know *which errors are trapped and which aren't. After testing and confirming the above, the technical representative said he would recommend that Ashton-Tate retest ON ERROR trapping systematically. Good idea.*

The most serious untrapped Error is [56] Disk Full, of course. Picture yourself as a novice user. Suddenly, you're told that the disk is full and asked 'Abort, Ignore, Delete?' Some choice! You can't select Ignore — it just LOOPs forever — so why is it even a choice? You shudder to think of deleting files, so the least awful choice is Abort, right?

*If you choose Abort, the screen flashes '**WARNING** Data will probably be lost. Confirm (Y/N).' Confirm what? If you say 'N', you're back to 'Abort, Ignore, Delete'. If you tough it out, you have no choice but to confirm Abort — and 'data will probably be lost'. At that point, you're greeted with 'Press <Enter> to assent to Licence Agreement & begin dBase III Plus', and the instant you touch any key, dBase CANCELs out of the program, stranding you at the dot prompt. The files are wide open, and serious damage has already occurred (the file you were writing is unreadable).*

Don't feel smug just because you've graduated to Clipper or FoxBASE. Clipper doesn't support ON ERROR at all, and if an error occurs, there's no dot prompt to help you put things back together again. FoxBase does trap Error [56] with ON ERROR, but you'd better write a whale of a recovery routine: I found newly appended records blank and the active databases locked out — you can't access them or close them — so the only alternative is to QUIT and restart. Your original file may be intact and renamed '.BAK' — you should check it first. If you were sorting when the disk overflowed, just erase the scratch files starting '0'.

Both Clipper and FoxBASE score better than dBase on Disk Full errors because they have additional functions like DISKSPACE() so a programmer can trap the error in advance. But when Error [39] occurs in either FoxBASE or Clipper, processing continues blithely unaware that a numeric overflow has just corrupted your TOTAL ON file.

In other words, if you want to create an absolutely bulletproof 'black box' program in the dBase language, you'd better learn to avoid death and taxes first — JT.

DOS prompt in dBase

It's sometimes convenient to be able to simulate the DOS prompt from within an otherwise black-boxed dBase application. DOSPROM.PRG, shown in Fig 12, will enable you to do this. If the programmer wants the utility of accessing DOS during development or debugging but doesn't want the end user messing around in DOS, he can hide the option in the menu. Naturally, to run DOS commands from within an application you need enough memory to load COMMAND.COM plus other programs called.

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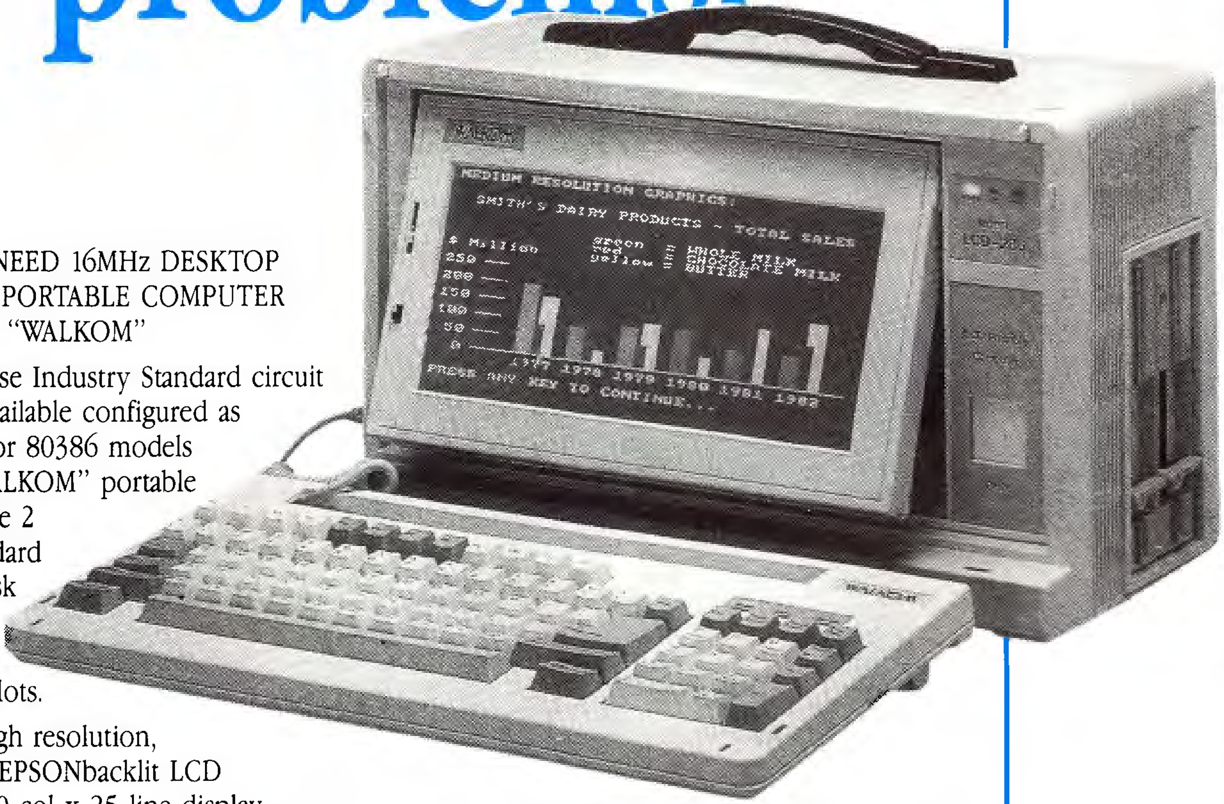
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```
100 ' Program to create LOX.COM -- by Grinnell Almy
110 CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 8:FOR C=1 TO 16:READ A$:T=T+VAL("&H"+A$):NEXT
130 READ S:IF S<>T THEN PRINT "ERROR IN LINE";B*10+180:END
140 T=0:NEXT:RESTORE
150 OPEN "LOX.COM" AS #1 LEN=1:FIELD #1,1 AS D$
160 FOR B=1 TO 8:FOR C=1 TO 16:READ A$
170 LSET D$=CHR$(VAL("&H"+A$)):PUT #1:NEXT:READ DUMMY$:NEXT
180 CLOSE:PRINT "LOX.COM CREATED"
190 DATA B8,00,00,8E,C0,BB,17,04,26,8A,07,BB,80,00,B4,01,1411
200 DATA 33,C9,8A,0F,83,F9,00,74,5E,83,E9,01,43,43,8A,17,1655
210 DATA 80,FA,2D,75,05,32,E4,EB,46,90,80,FA,2B,75,05,B4,1995
220 DATA 01,EB,3C,90,80,FA,61,7C,03,80,EA,20,80,FA,49,75,2004
230 DATA 05,B6,80,EB,1C,90,80,FA,43,75,05,B6,40,EB,12,90,1932
240 DATA 80,FA,4E,75,05,B6,20,EB,08,90,80,FA,53,75,10,B6,1955
250 DATA 10,80,FC,00,74,05,0A,C6,EB,05,90,F6,D6,22,C6,E2,2027
260 DATA AC,BB,17,04,26,88,07,B4,4C,B0,00,CD,21,00,00,00,1237
```

Fig 14 LOX.BAS program to create LOX.COM shift status controller. Syntax is LOX –/+ CNSI (where C, N, S, and I = Capslock, NumLock, ShiftLock, and Insert; + = on; – = off)

R F Glaap

Since your program will probably have open files when this routine is used, I would expand the prompt to include a warning:

@ ROW(),3 SAY [Please enter a DOS command] ??[(don't copy an open file) <CR>=Xit]

If you want to get really fancy, you can trap all commands where doscom begins with the verb COPY or XCOPY before it issues the command RUN &doscom. You may prefer different placement of the simulated DOS prompt, or even to CLEAR the entire screen. Finally, Clipper users should be sure to SAVE SCREEN before entering this routine, then RESTore it afterwards — JT.

QuickBasic library options

The documentation for QuickBasic's BuildLib utility on the PC implies that the only way to create a user library is to enter the name of each object module. This can be very tedious when trying to debug a single object module in a large library. An undocumented feature of BuildLab is the '/L' option, which lets you convert any library file created with LIB.EXE into a QuickBasic user library.

Many advanced Basic libraries sold by independent vendors are supplied in a .LIB format. The advantage of this is that you can maintain a large library of sub-programs, both Basic and assembler, using the LIB program that comes with the macro assembler. By using 'L' you can convert these into user libraries to be loaded into memory with the QB editor. Multiple libraries may be combined with one another by using the plus sign as you would normally do.

One problem you may encounter when building large libraries is getting a 'Too Many Segments' error message from QuickBasic. Since BuildLab is really just a variant of Link in disguise, you can also use the switches allowed by Link with BuildLib. To solve the 'Too Many Segments' error, just include the switch '/SE:n', where n is the number of segments you wish to use for the library. N must be in the range 1–1024. Otherwise, the default is 128 segments.

J Yeager

These are very useful options, but they're not the only ones Microsoft failed to document in the QuickBasic manual. You can also combine multiple object modules in a user library by specifying a response file instead of typing each module name.

To do this, first create a text file that contains the list of object modules to be included in the library. Put each name on a separate line, and add a plus sign after all but the last. When BuildLib asks for the object modules, enter an 'at' sign (@), followed by the response filename.

Another great feature that somehow was omitted from the manuals is the linker's ability to pack an .EXE program file. By adding '/E' on the command line that starts Link, you tell it to create a packed file that can be up to 20 per cent smaller than normal.

Speaking of linking, Microsoft really should include the Lib program with QuickBasic. I use it all the time to maintain my assembler utilities, and it can also include precompiled Basic programs in the same library. This way, instead of having to tell Link the name of each object module you can simply specify the library — JT.

Locked up

LOX.COM, created by assembling the LOX.ASM assembler code in Fig 13 or the Basic LOX.BAS program in Fig 14, is a simple program that gives you software control over the CapsLock, NumLock, ScrollLock, and Insert status on the PC. These four status bits are located in the high nibble of byte 417 of the BIOS data area, at segment 0. The program can set or clear any of the four bits.

Once you've created the program, enter LOX followed by any combination of the characters +, –, C, I, N, or S. The four letters stand for the four status bits: Caps, Insert, Num, and Scroll. The plus sign tells the program to set the bits for the following parameters, while the minus sign tells the program to clear the bits for all following parameters. If it finds parameters at the beginning of the command tail, before any plus or minus signs, it treats them as set parameters.

For example: LOX C sets CapsLock; LOX –N clears NumLock; LOX S–C sets ScrollLock and clears CapsLock; LOX –N+IC clears NumLock and sets Insert and CapsLock; and LOX CNIS sets all four locks. The program can handle shift states in any order, and in upper or lowercase. And it ignores any illegal parameters.

It begins by moving the keyboard status bit to AL, and the command tail length to CX, to control the loop. Then it reads each byte in the command tail. It maintains AH as a set/clear flag; if it finds a plus sign it sets AH to one; if it finds a minus sign it sets AH to zero.

If it finds anything else, it first converts it to uppercase if necessary, and then checks to see if it is one of the four valid parameters. If it is, it moves the appropriate code into DH, and then ORs DH with AL to set the bit, or else NOTs and then ANDs it with AL to clear the bit, depending on the status of AH. The program then loops back to read another byte from the command line. When the command line is exhausted, it moves AL back to the keyboard status byte.

G Almy

This program is especially useful now that IBM delivers systems that automatically set the NumLock on at boot-up. You may want to include a LOX –N line in your AUTOEXEC.BAT to fix this problem — JT.

END

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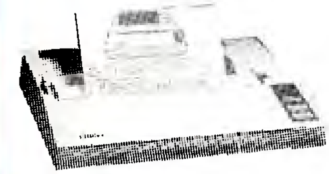

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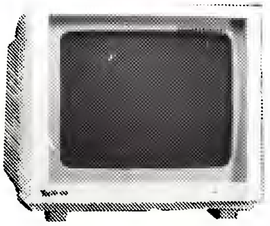

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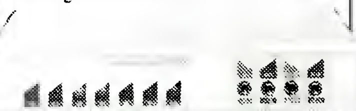

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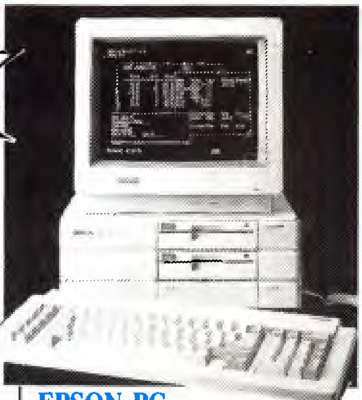

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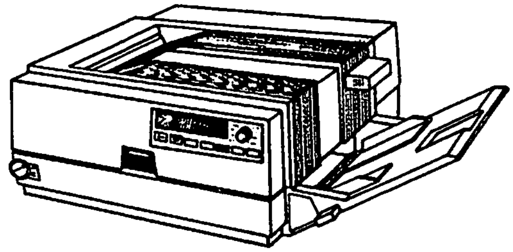

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Message for Fido

FidoNet started as the plaything of two comms enthusiasts. Today it's a worldwide electronic mail system linked to 2000 users. Steve Withers and Peter Tootill chart the rise of this professional network still run by 'amateurs'.

Most bulletin board users know that there is some sort of link-up between Fido bulletin boards — but not all realise that FidoNet (as it's called) is now a fully-fledged electronic mail system.

These days, too, FidoNet covers a lot more than just Fidos: other bulletin board systems (BBSs) such as Opus and TBBS can join in too and there are even some stand-alone electronic mail systems that use FidoNet protocols and can link into the system.

Worldwide network

Technically, FidoNet is a non real-time packet switching message system — in simple terms it is a sophisticated international electronic mail system.

However, instead of using a small number of mainframe computers like the commercial systems do, it runs on a large number of microcomputers which are all independently operated. There are currently about 2000 nodes on the world list — and I do mean *world list*. There are participating networks in North America (of course), Australia, most Western European countries, Singapore, Malaysia, Indonesia and the Southern and Western Pacific ocean area.

You can send a message to anyone using any of these systems simply by entering it on your nearest participating bulletin board system. The cost is very reasonable as well. A message can be sent to the US for not much more than the cost of an airmail letter (the actual costs vary because they are set by the sysops of the individual BBSs themselves).

Fido was the brainchild of an American called Tom Jennings. He and a friend, John Madill, lived on opposite sides of the United States and wanted a straightforward way of communicating with each other. This was in June 1984 and the first FidoNet messages were soon bouncing across the country.

Other bulletin board operators became interested and joined in. By August 1984 there were 30 nodes and in the Spring of 1985 nearly 200. The network has spread widely since then. Today there are over 2000 nodes of which about 1600 are publicly accessible. The rest are private systems that are members of the net for some particular reason.

Submissions

The material in this column is presented in good faith, but as it is collated from material provided by readers, *APC* cannot take responsibility for its accuracy. New information and corrections are always welcome (but please mention whether or not you can vouch for accuracy of the material provided), and should be sent to:
Steve Withers, C/- Computer Publications, 47 Glenhuntly Road, Elwood, Vic 3184 or to Viatel mailbox 0633000030.

Acknowledgements will normally be made through this column. You may also like to send a copy of the information to the Australian PAMS Coordinator at one of these addresses:

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The basic concept of FidoNet is very simple. Each participating BBS closes down at a set time (usually 3.30am local time) and assembles any outgoing messages into packets. It then dials other nodes and sends the packets, waiting between calls for incoming messages from other systems.

This process continues for about an hour, with systems alternately dialling and listening, after which they turn back into ordinary BBSs. The receiving system unpacks the messages and stores them in the bulletin board's message area ready for the addressee(s) to call in and read them.

In the early days, each node simply dialled other nodes direct and sent the messages. This soon became unworkable because of the number of systems trying to call each other and more complex structures were devised as a result.

The world was divided into three zones. Each zone is divided into regions and these are divided into nets. Nets usually consist of a dozen or so systems within the local call area of their host system. Messages are all routed via these hosts. This has several advantages: it cuts down on congestion and makes for more economical operation — the only long distance calls are between hosts and this mail is usually compressed and

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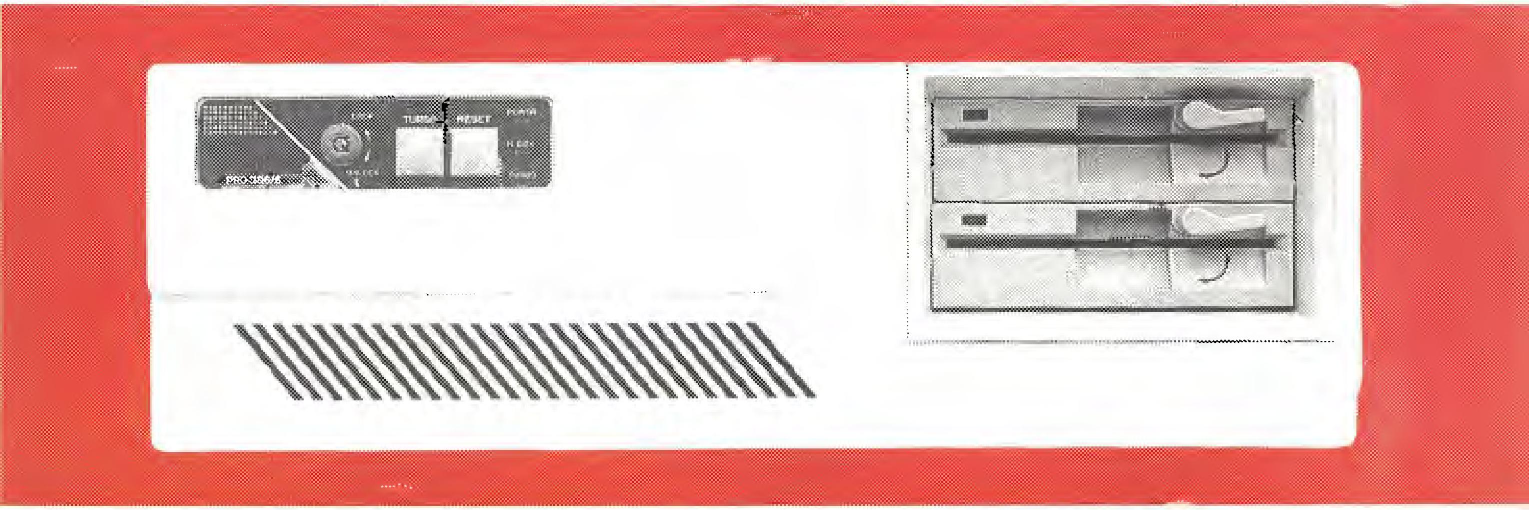

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sent using high speed modems. The whole system is designed to keep the actual online time, and hence running costs, to an absolute minimum.

FidoNet is operated entirely by amateurs. The node list is maintained by a group in St Louis and there are a series of levels of co-ordinator: one international co-ordinator, then three zone co-ordinators, about 30 regional co-ordinators and probably over 100 net co-ordinators. The whole set-up is overseen by the International FidoNet Association (IFNA). Despite the amateur nature of the system, it all appears to be run in a very professional and businesslike manner. Indeed it has to be, with 2000 participating systems there is no room for sloppiness!

Echomail

A recent enhancement to FidoNet is called Echomail. This adds conferencing to FidoNet's electronic mail capabilities. Until the introduction of Echomail, FidoNet was just a point-to-point system, in which a message was addressed to a node and then sent to that node.

With Echomail, several BBSs join together to carry a conference on a particular topic and all messages that are entered in the relevant section of each BBS are echoed to all the participating BBSs. This means that an individual can take part in an electronic conference that spans a number of systems simply by calling his or her local BBS. Echomail also has the ability to work on an international level.

Costs

Who pays for running the net and all the telephone calls involved in transferring messages? The cost of sending a message is usually borne by the sender. FidoNet has simple cost tables built in and these indicate the approximate cost of sending a message to any other node on the list.

The accounting system is relatively unsophisticated, making no allowance for the length of message or any attached files. If you want to use net mail, you send the sysop of your chosen BBS a few dollars which are then credited to your account. The cost of any message you send is then deducted from your remaining credit. Echomail costs are borne by the sysops of the participating BBS, but they may charge a small subscription to use the feature.

How to join

The main problem if you want to join the net (assuming that you are running a suitable BBS) is that there is a huge array of new concepts to learn. Also, some of the documentation is not very good. This is compounded by the fact that much of the software is public domain or shareware and there seems to be no single source of supply. You are dependent on another more experienced sysop to tell you what software you need and to help you get started.

Another thing you need, at least if you are going to use the world node list, is plenty of disk space. The list is about 150k in length and it is updated every week. This is done by means of a clever routine which uses a file containing the differences between last week's node-list and this week's.

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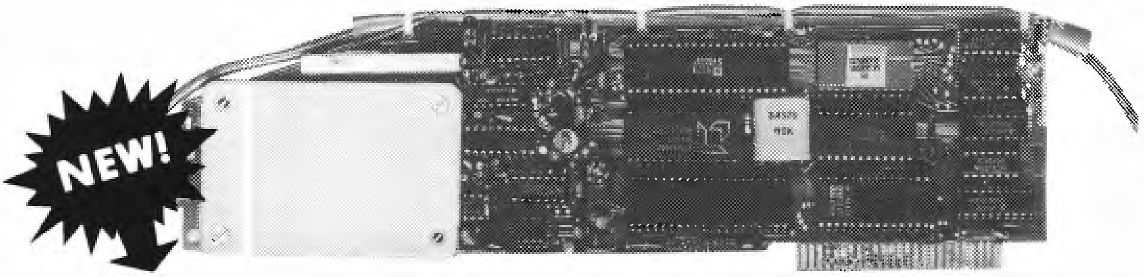

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— Select "(S) END A FILE" option
— Answer the prompt "FILENAME?:"

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*Main menu option "(V)IDEOTEXT" shows the VIATEL menu. It becomes a full graphics VIATEL terminal, automatically dialling and transmitting the user ID stored in the battery backed ram. When online, a keypress will immediately save pictures to memory. These can be reviewed later and selectively saved to disk or printed (requires a graphics printer card). Pictures can be loaded from disk and printed out. The modem can act as a videotext host and can be programmed to act on frame information, e.g. — use the clock to ring "MONEYWATCH" hurly and dial you at the office if your shares move outside a given range.

* TELESOFTWARE DOWNLOAD facility to purchase programs over VIATEL from suppliers such as MICROTEX 666 and TANGO.

* A full wordprocessor in EPROM for pre-composition of text before transmission. It can also be used to edit or print received files as well as for general wordprocessing.

* Onboard battery backed calendar clock can time and initiate calls or keep an activity log. ProDos uses it to time and date disk files and it is accessible from Basic.

* 2Kx8 battery powered CMOS RAM stores default parameters, phone numbers, ID, password, logon strings, search codes and setup parameters (e.g. baud rate, parity, printer ON) for each number, allowing single keystroke call establishment to specific areas of complex databases. Main menu option "(T)ELELIST" displays the list of 23 names and one is selected.

* Incorporates XON/XOFF and CHRISTENSEN error correcting protocol. Textfiles are not so fussy but error correction is a must when transferring program files. A debug function can display normally invisible control characters sent by the host.

* Can output directly to printer even when online at 1200 Baud — a fast printer is not required as the printer is spooled out of the receive buffer. A "FILTER" function is available to remove screen control characters from textfiles (these can drive a printer crazy). Special scroll routines print to 80 column screen and printer at 1200 Baud without any lost characters.

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before updating, and ask for too many sets of reports, the process can really gobble up disk space. I had over a megabyte free on a hard disk recently and ran out during the update. I was, however, applying two weeks' worth of updates and asked for a complete list of all nodes with their locations, phone numbers, sysops' names, and so on. The list when printed currently runs to 54 pages.

If you want to join the net, you need to be running a BBS that uses one of the software packages that can support net mail. Fido and the newer versions of Opus have net mail options built in. TBBS requires the addition of a package called Seadog. This is a standalone electronic mail system but it has no BBS features of its own — messages can be entered at the keyboard or received over the net but no-one can dial in and leave a message to be forwarded as they can with a Fido system.

As well as Seadog, TBBS needs a set of programs that extract messages from the net mail area and pass them to Seadog, and vice versa. Seadog can also be used with Fido and Opus as it gives extra features such as the ability to receive mail at any time (crash mail), not just during pre-defined mail slots.

If you are going to use the world node list you need a program that processes it and turns it from the format issued by the St Louis group into a form that can be used by Fido, and the others. A popular one is called XLATLIST, which also updates the list using the current NODELIST file and the latest difference file (called NODEDIFF).

Incidentally, XLATLIST has the most sweeping disclaimer I have ever seen: 'We accept no responsibility for anything at all'! After it has been processed, Fido 'compiles' the list. In effect this means constructing an index and a list of nets to speed up access. Some systems (Seadog included) have problems with large node lists and another shareware package called NLBUG has to be used.

Seadog is a commercial program but there is a public domain equivalent called Dutchie, which was written by Henk Wevers, a Dutchman, who is also the European FidoNet co-ordinator.

Dutchie is strictly shareware but, for the benefit of the ordinary amateur user, has the most generous level of user contribution I have come across — the author just asks you to send him a postcard.

Further reading

Further background information is contained in the following items which should be available from a number of FidoNet systems (Files are given in brackets, but these vary, so you may have to do a bit of detective work if you are trying to track them down on a BBS.)

Specification of Fido packet protocols (20 October 1984) (FIDOMAIL.DOC)
FidoNet protocols in OSI format (1987) (FCS001.PRN)
Early history of FidoNet (8 February 1985) (FIDOHIST.DOC)
IFNA policy (24 October 1986) (POLICY3.DOC)
Useful background article by Steve Townsley (Log On the Tyne) (1987) (ROUTING.TXT)
Fido's complete operating manual — Fidonet section (undated). (FIDONET.DOC)

System news

There is a good selection of updates and new systems this month. Bill Bolton maintains his place in the vanguard of the BBS community with what I believe is Australia's first FidoNet file server.

Acknowledgements: Larry Lewis and Greg Noonan.

New systems

NSW

Down Under (02) 674 6647. MV. Glen Myles.
EasyComm (02) 558 9620. MV. Michael Aldiholic. 9pm-7am weekdays, 24 hours weekends. V21, V22, V22bis. FidoNet 712/505.
First Nice MIDIline #2 (02) 868 4836. P. Andrew Khoo. Midnight–4am daily. V22, V22bis, Bell 103. FidoNet 711/805.
Landover (02) 550 1056. MV. Lance Lyon. V21, V22, V22bis, V23, Bell 103, 212.
NetComm Australia (02) 887 3297. File Server. Bill Bolton. 6pm–8am weekdays, 24 hours weekends. V22, V22bis, PEP. Software support system for FidoNet sysops — file support only. Wazoo and Bark requests honoured. (In other words, don't bother dialling in as if this were a normal system!)
Freeze World (047) 33 3094. P. Ashley Irons. 9.30pm–7.30am daily.
New Frontiers (046) 25 6954. Howard Pew. V21, V22, V23, Bell 103, 212.
Ventura Publisher (02) 449 0463.

Vic

Auzugs (03) 887 0678. P. Miklos Bolvary and Gordon Castle. V22, V22bis. FidoNet 631/326.
Crystal Palace (03) 725 1923. 'The Outsider'.
Soltec (03) 890 8166. MV. Jim Tsorlinis. 5pm–9am weekdays, 24 hours weekends. V22 only.
Time Warp (03) 813 1663. M. 'The Alien'. V21, V22.
Twilite Zone (03) 562 0686. M. 'Fearless Fred'. V21, V22.
Ballarat CAE (053) 339 285. MV. Paul Kelly. V21, V22, V23.
Excalibur (057) 83 1964. Maurice Copeland. 8am–noon, 4pm–11pm weekdays; 24 hours weekends. V21, V22, V23 originate and answer.

Qld

Apple-Q Node 2 (07) 800 4660. Kelvin Saggers. 9.30–5.30pm weekdays (weekend hours to be advised). V21, V22, V23.
Greenhorn (07) 345 5010. MV. Mike Richardson. 4pm–8am weekdays, 24 hours weekends. V21, V22, V22bis, V23.
Hotline Experimental (07) 353 3718. 'The Genius' 24 hours daily. V21, V23.

SA

Club (08) 263 5181. MV. John Pride. V21, V22, V22bis, V23.
Postie (08) 347 1046. 'Philip'. V21, V22, V22bis, V23.
S A C (08) 387 0249. MV. Austen Evans. V21, V22, V23 originate and answer, Bell 103, 212.

WA

Oasis ST (09) 383 1480. MV. Lou Schillaci. V21, V22.
Turing Circus (09) 385 2100. P. Phil Sutherland. V21, V22, V23, Bell 103, 212.

Updates

NSW

Alpha Juno (02) 774 1543. MV. Kevin Withnall. 6pm–6am. V22, V22bis only. FidoNet 620/701.
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Lodestone (02) 456 3264. Ian McWhirter. V22, V22bis, Bell 103. FidoNet 711/407.
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Playground (02) 53 9688. MV. Brett Selwood. V21, V22, V23 FidoNet 712/504.
RCOM (02) 667 1930. MV. Simon Finch. 24 hours daily. V21, V22, V23 (originate or answer), Bell 103, 212. For C64 users, must use RTERM.
Samilion Offline.
SMUG-BEE (02) 520 5181. MV. Bob Fryer. 24 hours daily. V21, V22, V22bis, V23.
Sydney PC Users Group (02) 221 5520. MV. Geoff May. 24 hours daily. V21, V22, V23.
Warringah Offline.
Comm Link (043) 41 3135. MV. 'Nuggets'. 24 hours daily. V21, V22, V23, Bel 103, 212.
Matrix (049) 38 5057. MV. Andrew Pike. V21, V22.
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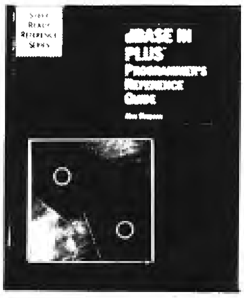

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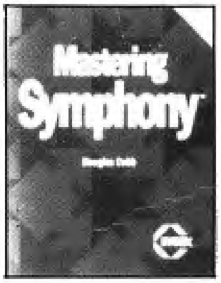

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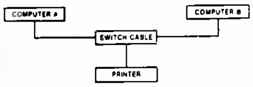

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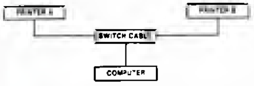

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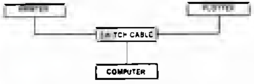

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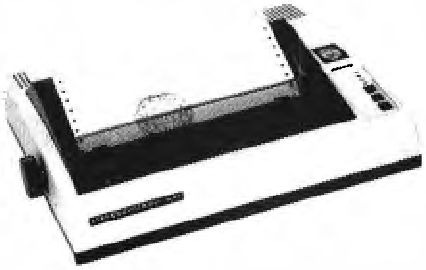

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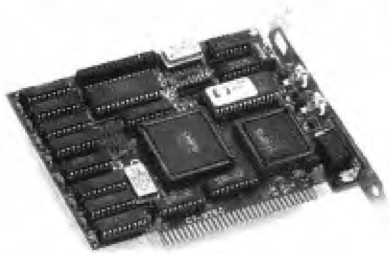

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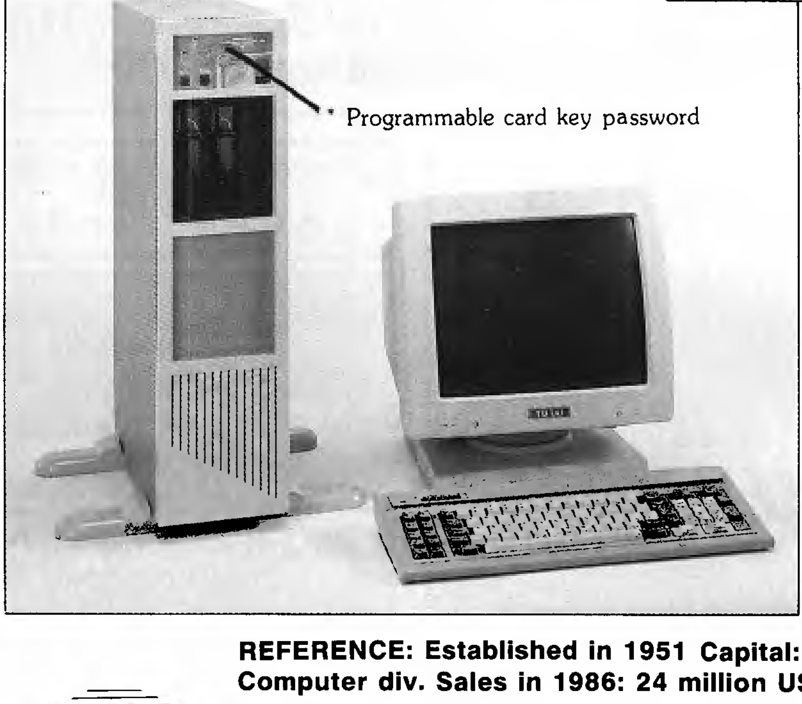

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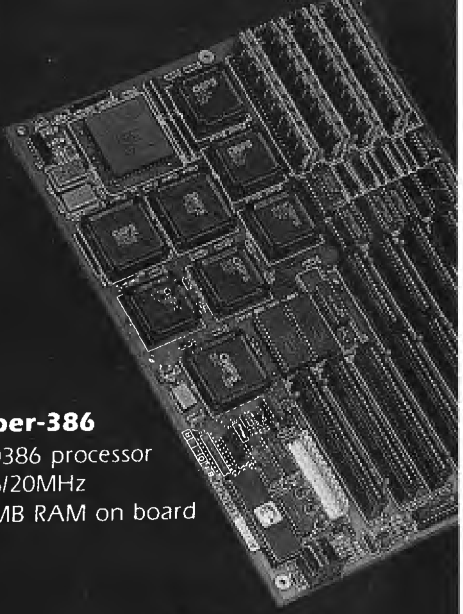

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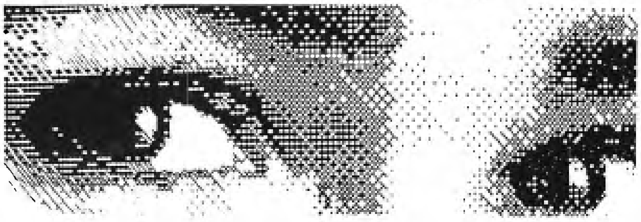

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Brainteasers courtesy of JJ Clessa.

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I am indebted to Lev — a holiday acquaintance — for this month's quickie. It may turn out to be more difficult than the prize puzzle — but there is no prize, and no answer will be published in *APC*.

You are given two unopened bottles of wine. You must open one bottle, but drink the wine from the other. How can this be done? (No breaking bottles, and only one bottle may be opened.)

Prize puzzle

I have three numbers — each of which is a perfect square. If I take the product of any two and add it to the sum of the two, another perfect square results. What are the three numbers?

More than one solution is possible; however, all numbers must be greater than zero.

Answers on postcards please, or *backs* of envelopes only, to reach the *APC* office no later than 31 December 1987.

Send your entry to: Lazing Around Prize Puzzle — December, *APC*, 124 Castlereagh Street, Sydney 2000

September prize puzzle

Okay, okay, so there are three solutions to the problem, not *two* as I stated. I think at last half of the eighty-odd entries told me so. The two answers which I computed on my micro were 4994 and 8778.

Because of a bug in my program I didn't check 9999, which is the third answer.

I accepted any two as qualifying for the prize and the winning entry came from John Lennon of Durack, Queensland. Contrats, John, your prize is on its way.

To all the near misses — keep trying.

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PO Box 468, Paddington NSW 2021.
Tel: (02) 332 4622

January 20-24, 1988

Electech '88
Venue: Thailand, TBC
Contact: Mr Carnchai Sawangsopakul, Thailand Exhibition and Management Co. Ltd,
15th Floor, Mahatun Plaza Building,
888/154-5 Ploenchit Road, Bangkok 10500.
Tel: 252 8063-5

February 9-12, 1988

Finance Melbourne '88 — International Exhibition of Technology, Equipment and Services in Finance, Banking and Insurance
Venue: World Trade Centre, Melbourne
Contact: BPI Exhibitions, 162 Goulburn Street,
Darlinghurst NSW 2012.Tel: (02) 266 9799

February 23-25, 1988

PACEX — Process and Control Engineering Exhibition
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Contact: Management Technology Education
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Contact: AMIC at RMIT (03) 663 6853

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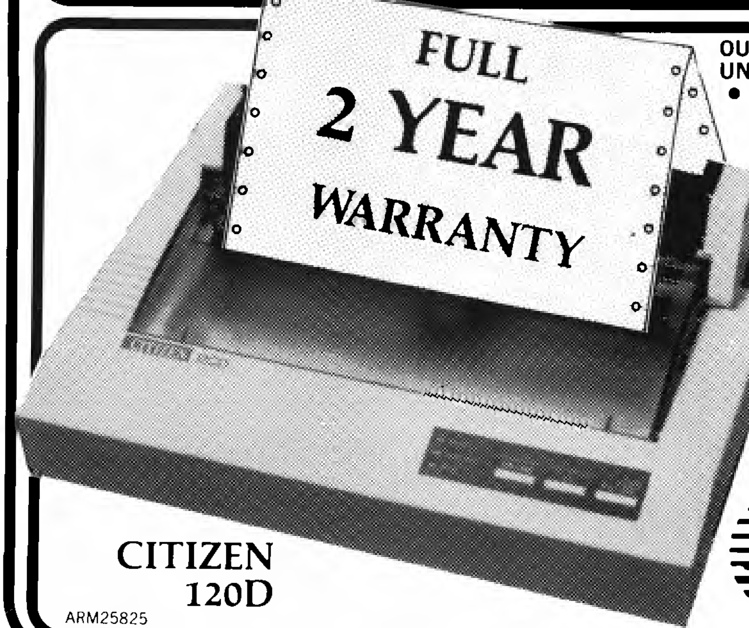

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Tel: (02) 327 4822

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Institute of Engineers Australian Annual Conference and Exhibition
Venue: Hilton International Hotel, Sydney
Contact: The Institute of Engineers,
118 Alfred Street, Milson's Point NSW 2061.
Tel: (02) 929 8544

March 16-19, 1988

PC-88 10th Australian Personal Computer Show
Venue: Centrepoint Tower, Sydney
Contact: Australian Exhibition Services,
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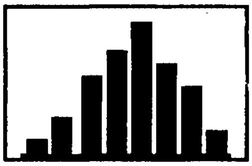

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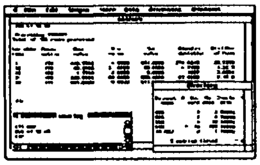

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Mike Mudge juggles with positive integers and is spellbound by powerful numbers and wonders, is this a case for geometric analysis?

Consider the n-digit positive integer, N, expressed in base 10 in the conventional manner: that is, $N = a_0 + a_1 \times 10 + a_2 \times 10^2..+a_{n-1} \times 10^{n-1}$ where $0 \leq a_i \leq 9$.

Given N, the idea is to construct a related positive integer, $F(N) = P_r(N)$ where r = 2,3,4,5 . . . , defined to be the sum of the $r^{th.}$ powers of the digits of N.

Thus P_2 (123) $= 1^2 + 2^2 + 3^3 = 14$sp, while $P_4(423) = 4^4 + 2^4 + 3^4 = 353$.

Now, if $P_r(N) = N$, then N is defined to be a 'powerful number' of degree r, to base N.

Some examples of powerful numbers to base 10:

Degree 3. $P_3(153) = 1^3 + 5^3 + 3^3 = 153$.

Degree 4. $P_4(1634) = 1^4 + 6^4 + 3^4 + 4^4 = 1634$.

Degree 5. $P_5(4150) = 4^5 + 1^5 + 5^5 + 0^5 = 4150$.

Degree 6. $P_6(548834) = 5^6 + 4^6 + 8^6 + 8^6 + 3^6 + 4^6 = 548834$.

Problem (i) Construct an efficient algorithm to 'dissect' a given positive integer, base 10, into its constituent digits base b.

Problem (ii) Generate all the powerful numbers of degree r to base 10 up to a given $N_{max.}$

Problem (iii) Provide a theoretical and/or empirical argument to define *all*

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Problem (iv) Generalise the results of (i) and (ii) to base b not equal to 10.

Is it possible to have a positive integer which is a powerful number (albeit with different degrees) in more than one number base? Furthermore, is there a possible geometrical interpretation of the above transformation?

If the two-digit integer, to base 10, a_1a_0, is regarded as representing (or being represented by) the point in the x,y-plane with coordinates $x = a_0$, $y = a_1$; and, similarly, in three-dimensional space for $a_2a_1a_0$ where $z = a_2$ is there a geometrical interpretation of the mapping defined by $P_r(N)$?

(1,5,3) is in some sense a 'fixed point' for the mapping defined by $P_3(N)$. The points (1,3,5), (3,5,1),(3,1,5),(5,1,3) and (5,3,1) can be regarded as joined to (1,5,3) by 'unit arrows' corresponding to one stage in the mapping: that is, geometri-

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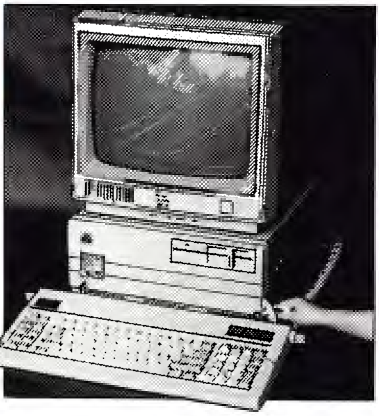

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cally $P_3(1,3,5) = (1,5,3)$.

Has this picture any physical significance?

When the numbers N involved have more than three digits, the geometry is in an n– dimensional hyperspace. Although this is difficult (if not impossible!) to visualise, the set of points associated with powerful numbers may be open to some interesting interpretation.

Readers are invited to suggest functions $F(N) = F([a_0,a_1,...a_{n-1}])$ other than $P_r(N)$ that may generate interesting results when iterated on the set of positive integers base b. Reference to Numbers Count, *APC* December 1983 ('The Persistence of an Integer') will provide one example of such an extension.

Send your attempts at this project to Mike Mudge, C/- *APC*, 124 Castlereagh Street, Sydney 2000, to arrive by 15 January 1988.

It would be appreciated if such submissions contained a brief summary of results obtained, in a form suitable for publication in *APC*. These submissions will be judged using subjective criteria, and a prize will be awarded by *APC* to the 'best' contribution received by the

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Review: W-sequences, May

W_1
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W_4 W_5 W_6 W_7

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This structure leads directly to certain generalisations concerning junction points: thus if Z is a junction point of W(a,b,c,d_1,d_2) then all members of W(a,b,z,d_1,d_2) are also junction points of that sequence. Computation and counting of terms of W-sequence involves no essential difficulty, efficient sorting is merely needed at the final stage. Determination of a particular term, for example the 2157th in a particular W-sequence such as W(2,3,1,1,1), can be readily carried out by repeated division of 2157 by 2 noting the presence of a non-zero remainder. (Answer, 30646.)

Junction points for W(2,3,1,1,1) start with $Z_1 = w_{11} = w_{16} = 31$, $Z_2 = w_{22} = w_{32} = 63$, $Z_3 = w_{23} = w_{33} = 94 \ldots w_{271} = w_{191} = 2551 ., \ldots w_{383} = w_{543} = 7654 \ldots$

Some combinations of parameters which do not yield junction points were discovered, including (i) a & b both even, +(ii) d_1 and d_2 one odd and other even.

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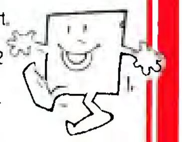

Reviewers at BYTE, Dr.DOBB'S JOURNAL, DATA BASED ADVISOR, and INFOWORLD, all came to the same conclusion - BRIEF IS BEST!

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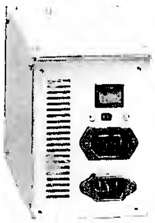

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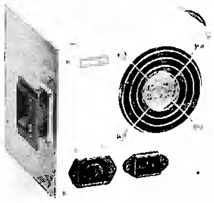

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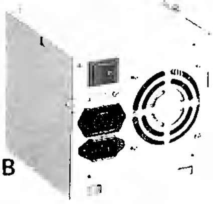

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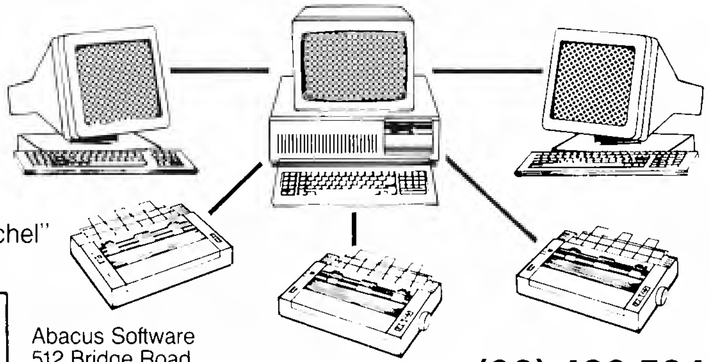

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This month prizes go to Gareth Suggett for a combination of theoretical observations and computation, and also to Philip Newton Webb for considerable analysis and flow-charting relating to W-sequences.

Mike Mudge welcomes correspondence on any subject within the areas of number theory and other computational mathematics. Particularly welcome are suggestions, either general or particular, for future Numbers Count articles; all letters will be answered in due course.

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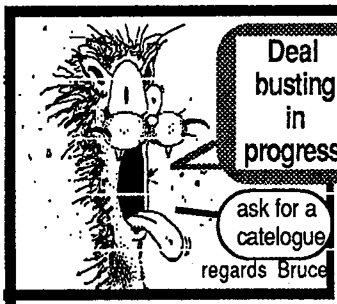

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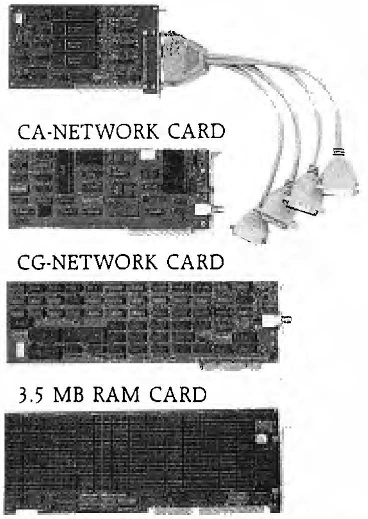

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